Onondaga Lake Nonpoint Source Environmental Benefit Project

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Syracuse, NY

Submitted by
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In association with
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1 EXECUTIVE SUMMARY

1.1 Background

Nonpoint source (NPS) pollution is unlike industrial and municipal pollution; it comes from diffuse sources and is the result of rainfall or snowmelt moving over and through the ground. NPS pollution is usually associated with land use activities such as agricultural, construction and urbanization and include pollutants such as fertilizers, herbicides, pesticides, insecticides, sediment, bacteria, nutrients, oils and grease and toxic chemicals.

The objective of the Onondaga Lake Nonpoint Source Environmental Benefit Project (EBP) was to implement nonpoint source controls and management strategies to reduce nutrient inflow to Onondaga Lake from agricultural and urban practices and to evaluate the effectiveness of these controls and management strategies.

Onondaga Lake is located immediately northwest of the City of Syracuse in Onondaga County, New York. The Onondaga Lake drainage basin encompasses approximately 247 mi^2 (642 km^2) and, with the exception of 0.75 mi^2 (2 km^2) in Cortland County, lies almost entirely in the Onondaga County drainage basin. The basin includes six natural subbasins: Nine Mile Creek, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook and Saw Mill Creek. The City of Syracuse is the region's major metropolitan center, encompassing approximately 20 square miles. The City of Syracuse together with the adjacent towns and villages have been designated an urban area by the State of New York, and thus fall under the Phase II stormwater regulations. The urban area including the City of Syracuse is approximately 100 square miles. The non-urban areas of the Onondaga Lake watershed include mostly forest and agricultural lands. The Onondaga County Soil and Water Conservation District estimated a total of 107 active farms including 67 active dairy farms in 1992. The land use attributed with these farms 37,181 cropland acres including 3,721 acres of pastureland. The current estimate of total farms is 98.

The selected agricultural sites were chosen to represent the prominent agricultural trends in New York State. Specifically, the Rohe Farm represents a typical family-owned, 100-head dairy farm that plans to continue operations as usual. The Guptill Farm is a family-owned farm that recently made the transition from dairy farming to beef cattle and heifer-livestock handling. The Leubner Farm is also a family-owned dairy farm but has expanded from a 150-head operation to more than 400-head operation.

The selected urban sites were chosen to represent typical municipal urban runoff. A stormwater vegetative filter strip was installed at the Burnet Park Zoo to treat and control runoff from a typical urban parking lot. A stormwater vortex unit was installed on East Seneca Turnpike to treat runoff from a major city street.

There were three major elements of work for the EBP: 1) *BMP design and implementation*, 2) *water quality monitoring* and 3) *effectiveness evaluation*.

BMP design and implementation included BMP identification and selection and design and construction. Working with the farmers and municipal representatives was especially important during this phase of work in order to ensure their commitment to the operation and maintenance of the BMPs. BMP design and implementation started in June 1999 and continued until November 2001.

Water quality monitoring for the agricultural sites was conducted from May 1999 to May 2000 for pre-BMP period and November 2000 to November 2001 for post-BMP period. During each period, water quality samples were collected in the receiving water adjacent to the farmstead. The intent of this sampling was to monitor the reduction of pollutants in the receiving water as a result of the group of BMPs installed on the farmstead. Water quality sampling for the urban BMPs effort began during the spring of 2001 after the BMPs were installed. For the urban BMPs, influent and effluent samples were taken during actual wet-weather events to define removal efficiency.

Effectiveness evaluation began immediately following implementation of the BMPs beginning in November 2000 and continued until March 2002. The effectiveness evaluation included site visits, farmer interviews and analysis of water quality data.

1.2 BMP Design and Implementation

The agricultural BMP selection and design process used a combination of newly established approaches and efforts that were customized to fit the nature of the project. Under this project, Tier I and II Assessments from the Agricultural Environmental Management (AEM) guide for New York State were completed to identify water quality risks and suitable BMPs. Tiers III to V Assessments were not completed since the objectives differed from those of the Soil and Water Conservation District; the EBP project was confined to farmstead-scale problems and remedies and not geared towards long-term soil management efforts. The Tier I and II Assessments led to the design and construction of BMPs, and efforts were made to have all BMPs comply with Natural Resources Conservation Service (NRCS) specifications. Based on the assessments, it was decided during the early stages of the project that targeting manure handling practices and animal pasturing adjacent to receiving waters would provide the greatest return on the investment in terms of nutrient reductions. Most of manure handling improvements were made through reengineering the manure handling stations and providing training to the farmer on proper operation. Creating a buffer zone between the receiving waters and active livestock areas and manure handling stations also provide a relatively inexpensive benefit to water quality. A simple principle was maintained throughout design and construction of BMPs: keep the clean runoff clean and divert the contaminated runoff to a treatment area.

The selected urban BMP were chosen to represent treatment for typical municipal urban runoff. A stormwater vortex unit was installed at 134 East Seneca Turnpike for the purpose of removing suspended solids and associated nutrients from the stormwater before discharge to Onondaga Creek. The catchment area serviced by this unit primarily encompasses a 1,000-feet length of East Seneca Turnpike and is approximately 1.2 acres in size. The unit is a 4-foot diameter Hydro International Downstream Defender® with a design flow of 0.75 cfs and a maximum capacity of 3.0 cfs. A stormwater vegetative filter strip was installed at the Onondaga County Burnet Park Zoo for the purpose of controlling and treating runoff from a parking lot. The original stormwater structure for this parking lot was a cobblestone-lined ditch, which was constructed around 1985 and no longer effectively conveyed stormwater. The vegetative filter strip was installed to replace the cobblestone-lined ditch. The vegetative BMP is a 160-foot long swale, which collects and conveys runoff from the parking lot. The ditch was reshaped to convey flow at rates that minimize erosion. The area was seeded with a mixture of grasses. These grasses were selected to be resilient against invading species, to grow well in a wet and dry environment and to only grow to approximately two feet tall.

1.3 Water Quality Monitoring

The EBP water quality sampling program provided data that were intended to provide only a first order approximation of farmstead and urban runoff pollutant concentrations and effectiveness of BMPs. Prior to this sampling program there were no site-specific data for urban and farmstead runoff available for the City of Syracuse and surrounding agricultural land. This sampling approach was consistent with budgetary constraints, which allocated 85% of the budget for BMP implementation and the remaining 15% for sampling and monitoring, laboratory analyses, data analyses, meetings and reporting.

Water quality analyses following USEPA approved methods were performed for Soluble Reactive Phosphorus (Ortho-Phosphorus), Total Phosphorus (Total-P), Total Kjeldahl Nitrogen (TKN), and Total Suspended Solids.

Water quality samples for the agricultural BMPs were collected in the receiving water adjacent to the farmstead once per month for one year before and after BMP implementation. Instantaneous flow measurements were taken at the same time as the water quality data. The intent of this sampling was to monitor the reduction of pollutants in the receiving water as a result of the group of BMPs installed on the farmstead. Using the water quality concentrations and the flow measurements, pounds (i.e. loads) of pollutants discharged from the farmsteads were estimated. These loads were used to identify pre- and post-BMP load reductions as well as for estimating relative loads discharging from such farmstead in the receiving waters of Onondaga Lake.

Water quality sampling for the urban BMPs effort began during the spring of 2001 after the

BMPs were installed. For the urban BMPs, influent and effluent samples were taken during actual wet-weather events to define removal efficiency. Six wet-weather events were sampled for each the vortex unit and the vegetative strip.

1.4 Effectiveness Evaluation

In the agricultural setting, pollutant concentrations significantly decreased from the pre-BMP sampling period to the post-BMP sampling period at all three farms. Pollutant concentrations from each sampling event were ranked using the Wilcoxson Rank-Sum Test. This comparison approach (alpha = 0.05, 95% confidence) indicated a significant reduction in concentration from the pre-BMP sampling to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced the concentration of pollutants discharging from the farms.

The following table provides pounds of pollutants discharged during the pre- and post-BMP periods and percent removals.

	Pre-BMP (pounds)	Post-BMP (pounds)	Percent Removal
Rohe Farm			
Total Phosphorous	865	265	70%
Total Kjeldahl Nitrogen	2,830	900	68%
Guptill Farm			
Total Phosphorous	1,700	684	61%
Total Kjeldahl Nitrogen	10,400	2,174	79%
Leubner Farm			
Total Phosphorous	799	359	55%
Total Kjeldahl Nitrogen	5,837	2,922	50%

There are approximately 50 active farms within the Onondaga Lake watershed without BMPs. If it is assumed that the three farms studied during this project are representative of the 50, than the findings from this project equate to approximately 20,000 to 50,000 pounds per year of potential total phosphorus reduction and approximately 45,000 to 410,000 pounds per year of potential TKN reduction within the watershed. Assuming that 50% of the TKN is ammonia-N, than there is approximately 22,500 to 205,000 pounds per year of potential ammonia-N reduction.

As a frame of reference, based on current Metropolitan Sewage Treatment Plant (METRO) upgrade plans, the potential total phosphorus reduction at METRO is 66,500 pounds per year and the potential ammonia-N reduction is 550,000 pounds per year.

The cost of BMP construction and implementation on each farm was approximately $45,000. This equates to approximately $45 to $112 per pound of total phosphorus removed per year and $10 to $100 per pound of ammonia-N removed per year. As a frame of reference, Onondaga County is investing approximately $125 million (1997) at METRO for phosphorus and ammonia removal during the period from 1996 to 2015. This equates to approximately $1,900 per pound of total phosphorus removed per year and $230 per pound of ammonia per year.

The stormwater vortex unit was monitored for just over a one-year period from March 2001 until May 2002, during which time approximately 40 inches of rain fell during the non-winter months. This equated to approximately 730,000 gallons of stormwater processed by the vortex unit. Also during this time approximately 100 cubic feet of material was removed from the vortex unit weighing an estimated 4,500 lbs. This equated to approximately 0.14 cubic feet or 6 lbs of material removed per 1,000 gallons of stormwater processed. Most of the material removed from the vortex unit was sand and grit and organic material such as leaves and twigs. Relatively little nutrients were removed, which was likely due to the low influent concentrations of nitrogen and phosphorus. Additionally, relatively little trash was collected as a result of the grated catchbasins, which prevent trash from entering the stormwater conveyance system. The sediment storage sump of the vortex unit is approximately 12 cubic feet; maintenance is key to the successful operation of such equipment because once the unit's sump is full, a reduction in removal efficacy is possible due to the increased risk of re-entrainment of solids deposited within the zone above the shielded sediment storage sump.

The vegetative filter strip was monitored for roughly five months from June 2001 until October 2001, during which time approximately 16.5 inches of rain fell. This equated to approximately 40,000 gallons of stormwater processed by the 160-foot long vegetative filter strip. Water quality sampling was conducted on six storm events beginning in June of 2001 and ending in October of 2001. For half the events sampled, the vegetative filter strip absorbed the stormwater and no effluent flow was apparent. During the other three sampling events, rainfall and the resulting parking lot runoff were great enough to cause flow through the vegetative filter strip. It appears that the strip could absorb about one inch of rain before effluent flow was apparent; this is equivalent to approximately 3,000 gallons of stormwater. The vegetative filter strip appeared to be effective at removing solids during a flow through condition. However, concentrations of solids were relatively low. It also appeared that the vegetative filter strip was acting as a nutrient exporter; releasing nutrients when stormwater flowed through the strip. Again, the nitrogen and phosphorus concentration in both the influent and effluent was very low. The source of the nutrient reservoir was likely from the compost bedding established for seeding.

2 INTRODUCTION

Nonpoint source (NPS) pollution is unlike industrial and municipal pollution; it comes from diffuse sources and is the result of rainfall or snowmelt moving over and through the ground. As the water travels it carries human-source and animal-source pollutants. NPS pollution occurs over a wide area and is usually associated with land use activities such as agricultural cultivation, grazing, construction, urbanization and forest management. These pollutants may include fertilizers, herbicides, pesticides, insecticides, sediment, bacteria, nutrients, oils and grease and toxic chemicals.

The objective of the Onondaga Lake Nonpoint Source Environmental Benefit Project (EBP) was to implement nonpoint source controls and management strategies to reduce nutrient inflow to Onondaga Lake from agricultural and urban practices and to evaluate the effectiveness of these controls and management strategies.

2.1 Amended Consent Agreement

In January 1998, Onondaga County executed an Amended Consent Judgment (ACJ) in settlement of litigation initiated in connection with alleged violations of state and federal water pollution control requirements. The ACJ obligated Onondaga County to perform NPS environmental-benefit projects (EBP) in the Onondaga Lake watershed. This obligation was partly based on the results of a framework watershed model that was developed in 1994. The model identified nutrient loadings throughout the Onondaga Lake watershed on the basis of loading provided by Agway, Inc. and land use provided by the USDA, Natural Resources Conservation Service (Moffa and Associates, 1995). As depicted in Figure 1, it was projected that NPS phosphorus contributed the greatest annual loads to Onondaga Lake.

The EBP obligations are being met through this demonstration project involving best management practices (BMPs) implementation on three farms and two urban sites in the Onondaga Lake watershed. The major objective of the demonstration project is to implement BMPs to reduce nutrient inflow to Onondaga Lake and document water quality before and after BMP implementation.

2.2 Scope of Work

There are three major elements of work for the EBP: *BMP design and implementation, water quality monitoring* and *effectiveness evaluation.*

BMP design and implementation spanned much of the project time period from March 1999 to November 2001. This work element can be further broken into potential BMP identification,

selection, planning, design, farmer review, bid and contract, construction, implementation and modifications. BMP identification, selection, farmer review, bid and contract proceeded from March 1999 to October 2000. BMP construction, implementation and modifications began in June 2000 and continued until November 2001. The timeframes for activities varied for each farm with work proceeding most rapidly at the Rohe Farm, then Guptill Farm, with the later dates involving work at the Leubner Farm.

Water quality monitoring work began with the installation of rain gauges in May 1999. Water quality samples were collected starting in May 1999 to May 2000 for pre-BMP conditions. Water quality samples were collected from November 2000 to November 2001 for post-BMP conditions.

Effectiveness evaluation began immediately following implementation of the BMPs beginning in November 2000 and continued until March 2002. This corresponded with the resumption of sampling for post-BMP conditions. The effectiveness evaluation included site visits, farmer interviews and analysis of water quality data.

BMP design and implementation focused on typical agricultural and urban nonpoint pollution sources. Each agricultural site included a series of related BMPs to reduce nutrient runoff from the farming operations. An operation and maintenance (O&M) plan for each farm was developed with the farmer. The O&M plan identified water quality risks and corrective BMPs to reduce the risk. It was essential to have the farmer co-develop the O&M plan to ensure that the BMPs complemented the farmer's existing farming operations and were economically viable for operation and maintenance by the farmer. The urban BMPs, namely a vegetative filter strip and a stormwater vortex unit, were selected to represent typical structural and non-structural BMPS. The selection of these BMPs as well as the final siting and design were approved by the City of Syracuse municipal engineers and elected officials.

In order to determine the effectiveness of the agricultural BMPs, *water quality monitoring* was conducted on a monthly basis during wet weather/higher flow events. Additional sampling occurred during the snowmelt season since as much as 90% of the yearly annual load can occur during the spring runoff period (WERF, 1999). Approximately one year of water quality data prior to and after BMP implementation was collected. Samples were analyzed for total suspended solids, total Kjeldahl nitrogen, total phosphorus and ortho-phosphorus.

In order to determine the effectiveness of the urban BMPs, monitoring was conducted on the influent and effluent during actual stormwater runoff events. Six events were sampled. These events varied in peak flow and duration, thereby providing a large range of water quality.

The effectiveness evaluation served to demonstrate the measurable water quality benefits of the BMPs. The effectiveness of the BMPs at each agricultural site was assessed through the comparison of water quality data from the pre- and post-BMP periods, which included estimates

of loads using calibrated hydrographs. Additionally, hydrographs for the typical water year were developed for each agricultural site. These hydrographs together with the water quality data were used to estimate a first-order approximation of pollutant loads.

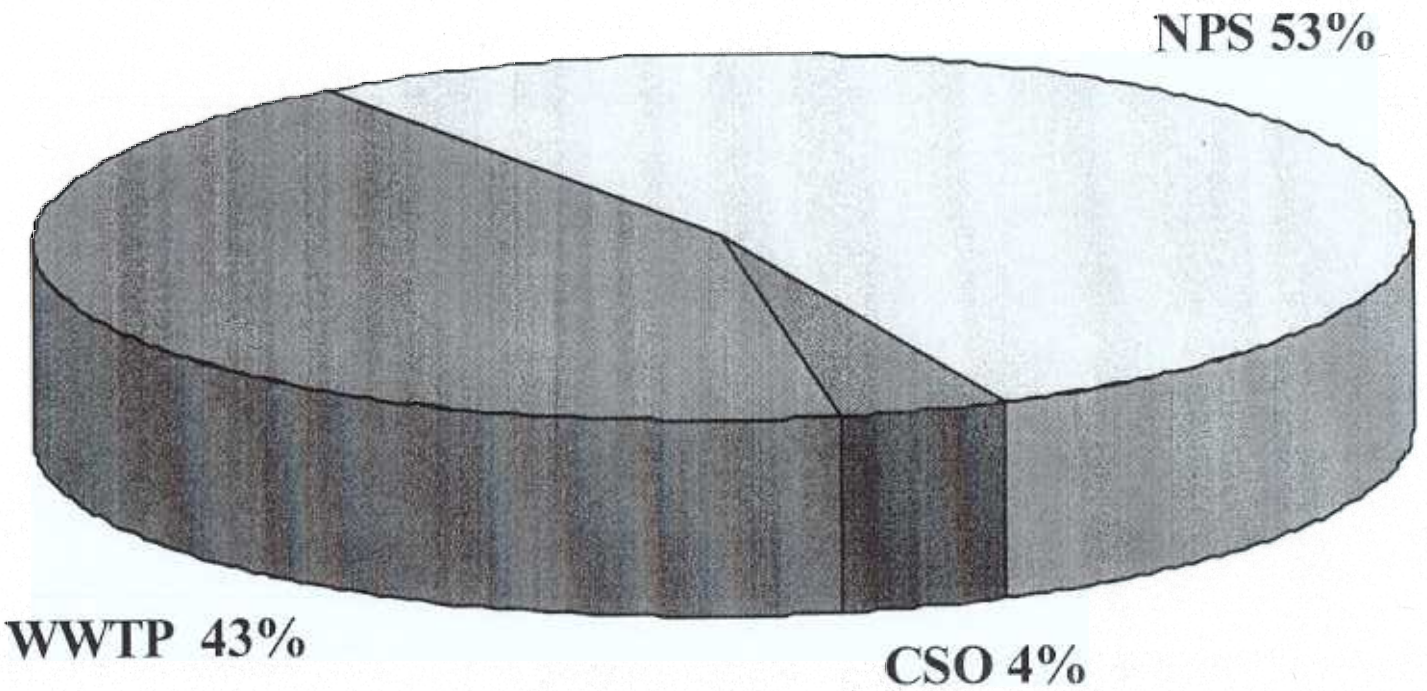
The urban data analysis focused on influent and effluent comparisons. Pollutant loads for a typical water year were also generated from the urban sites.

2.3 Environmental Benefits Projects

The three agricultural sites and two urban sites are identified in Figure 2.

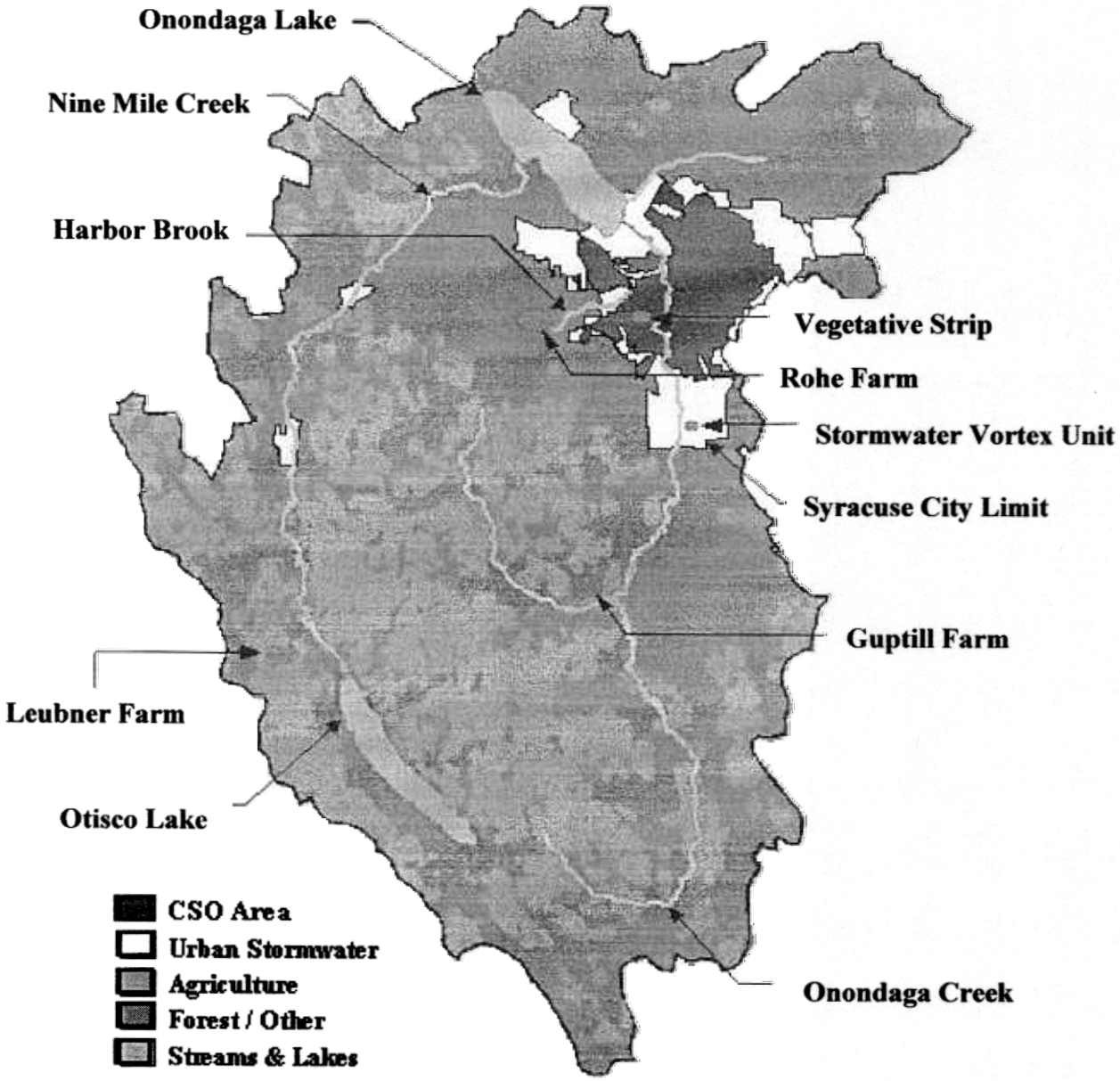
The agricultural sites were chosen to represent the prominent agricultural trends in New York State. Specifically, the Rohe Farm represents a typical family-owned, 100-head dairy farm that plans to continue operations as usual. The Guptill Farm is a family-owned farm that recently made the transition from dairy farming to beef cattle and heifer-livestock handling and is currently in the process of organic certification. The Leubner Farm is also a family-owned dairy farm but has expanded from a 150-head operation to more than 400-head operation. Although these farms vary significantly in their current operations and practices, they can all be considered "typical" of trends in the New York State agricultural industry.

The urban sites were chosen to represent typical municipal urban runoff. The stormwater vegetative filter strip at the Burnet Park Zoo treats and controls runoff from a typical urban parking lot. The stormwater vortex unit on East Seneca Turnpike treats runoff from a major city street. The catchment area on East Seneca Turnpike is very steep and is treated with heavy applications of salt and sand during winter months.



Source: Moffa P.E., S. Nix, S. Dent, 1995. A Watershed Approach to CSO Abatement, Onondaga County, New York. Reported to Onondaga County Department of Drainage and Sanitation, Syracuse, NY.

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Onondaga Lake Phosphorous Load Sources**	**Figure 1**



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Onondaga Lake Watershed, Nonpoint Source EBP
Location of Agricultural Sites and Urban Sites

Figure 2

3 BACKGROUND

3.1 Description of Onondaga Lake and Watershed

This section has been adapted from the Onondaga Lake Ambient Monitoring 2000 Annual Report prepared for Onondaga County by EcoLogic, LLC (Cazenovia NY).

3.1.1 Onondaga Lake

Onondaga Lake is located immediately northwest of the City of Syracuse in Onondaga County, New York, USA (43° 6' 54" N, 76° 14' 34" W). The outlet of Onondaga Lake flows into the Seneca River which joins with the Oswego River and flows north and east into Lake Ontario.

The Onondaga Lake drainage basin encompasses approximately 285 mi^2 (738 km^2) and, with the exception of 0.75 mi^2 (2 km^2) in Cortland County, lies almost entirely in the Onondaga County drainage basin. The basin includes six natural subbasins: Nine Mile Creek, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook and Saw Mill Creek.

The climate of the Onondaga Lake basin is continental humid and is strongly influenced by proximity to Lake Ontario and the presence of the Appalachian upland in the southern part of the drainage basin. Lake Ontario moderates the temperature extremes. The warmest month is July with a mean daily maximum temperature of 81.9° F. January is the coldest month; mean daily minimum temperature is 14.9° F. Based on the 1951-1980 period, the average frost-free period is April 29 through October 15. Lake effect contributes high amounts of cloudiness and snowfall. The summer months are drier on average but high year-to-year variation is typical. The average annual precipitation ranges from 37 to 40 inches of water. The total annual precipitation for the years 1999, 2000 and 2001 is presented below.

- 1999 30.84 (inches water equivalent)
- 2000 36.07 (inches water equivalent)
- 2001 34.39 (inches water equivalent)

Onondaga Lake is relatively small, with 4.7 mi (7.6 km) maximum length, 1.2 mi (2 km) maximum width, 4.5 mi^2 (11.7 km^2) surface area, 36,136 x 106 gallons, 35.76 ft (10.9 m) mean depth, and 64 ft (19.5 m) maximum depth. The Onondaga Lake shoreline is very regular with few embayments. More than 75 percent of the shoreline is owned by Onondaga County and is maintained as part of a popular park and trail system. The lakeside park is currently used for recreation (hiking, biking, jogging, roller-blading, etc.), fishing and cultural entertainment. The lake is used for secondary water contact recreation such as boating and water skiing.

Fishing was prohibited in the lake in 1972 due to mercury contamination. The prohibition was lifted in 1986 and modified into a catch and release fishery, i.e., recreational fishing was permitted but possession of lake fish was not. In 1999 the New York State Department of Health revised its advisory regarding consumption of game fish from Onondaga Lake. The current recommendation is to eat no walleye from Onondaga Lake and to restrict consumption of all other species to no more than one meal per month. The fish advisory continues to be based on mercury levels in fish flesh.

3.1.2 Tributaries

Onondaga Lake has four major natural tributaries and one major effluent discharge from a regional wastewater treatment plant.

Nine Mile Creek. Nine Mile Creek is the second largest natural tributary to Onondaga Lake with a drainage area of approximately 115 mi^2 (298 km^2). The watershed encompasses the Nine Mile Creek, Geddes Brook and Otisco Lake sub-watersheds as well as lands southwest of Onondaga Lake. Nine Mile Creek originates at the outlet of Otisco Lake, flows north and enters Onondaga Lake at Lakeland adjacent to the New York State Fairgrounds. The main stream length is 34.3 mi (55.2 km) and the stream flow for Nine Mile Creek is gauged at the USGS station located at Route 48 in Lakeland. Nine Mile Creek receives treated municipal wastewater from the Village of Marcellus as well as overflow and infiltration from the Allied Signal waste beds in the lowest 1.7 mi (3 km) of the stream.

Harbor Brook. The Harbor Brook watershed drains a long and narrow area of 12.9 mi^2 (33.5 km^2) southwest of the lake and enters the lake approximately 0.62 mi (1 km) southwest of Onondaga Creek. The main stem length is 7.5 mi (12.1 km). Land use in the headwater segment of the Harbor Brook watershed is a mixture of agriculture and residential. As the brook flows through the City of Syracuse land use becomes increasingly urban; the lower reaches of the watershed include areas of high-density residential, commercial and industrial land uses. Eighteen combined sewer overflows (CSOs) discharge to the lower reaches of Harbor Brook. Streamflow is gauged at USGS stations located at two sites: Velasko Road and Hiawatha Boulevard.

Onondaga Creek. The Onondaga Creek watershed drains an area of 111.6 mi^2 (289 km^2). The Creek originates in the Tully Valley, flows north and enters the lake as the New York State Canal System along the southern shore. The main stem length is 27.5 (44.2 km). About one-third of the creek is located in the City of Syracuse. The Creek receives urban runoff, including 43 CSOs. Groundwater contamination from current and historical industrial activities along the banks of Onondaga Creek may also impact Onondaga Creek's water quality. Onondaga Creek represents the largest source of water to Onondaga Lake. Streamflow is gauged at USGS stations located at two sites: Dorwin Avenue and Spencer/Kirkpatrick Streets.

A unique feature of Onondaga Creek is the discharge of sediment-laden (turbid) groundwater from mud boils in the Tully Valley in the creek's headwaters segment. The Tully Valley mud boils are volcano-like cones of fine sand and silt that have been a landscape feature since the late 1890s (Kappel and McPherson 1998). According to these USGS investigators, flow from a mud boil is driven by artesian pressure that forces water and sediment upward from sand and gravel aquifers through a 60-foot layer of dense silt and clay. The artesian pressure within the aquifer can lift water 20-30 feet above land surface. The source of the water is surface water that infiltrates to groundwater along the valley walls. USGS has implemented three remedial actions in the mud boil area to reduce loading of suspended solids to Onondaga Creek and ultimately Onondaga Lake.

Ley Creek. The Ley Creek watershed extends eastward from the southern end of Onondaga Lake and covers an area of approximately 28.7 mi^2 (75 km^2). The headwaters drain mainly wetlands but the majority of the drainage flows through residential and industrial sites. Two CSOs discharge to Ley Creek. Within the basin are a number of large commercial and industrial sites, dredge spoil disposal areas and several closed landfills that received both sanitary and industrial waste.

Metropolitan Sewage Treatment Plant Effluent (Metro). Treated effluent from Metro enters the lake at the southeast end. In most years Metro effluent represents the third largest source of water to Onondaga Lake. Most of the water treated at Metro originates in Skaneateles Lake and Lake Ontario which are situated outside of the Onondaga Lake drainage basin. A small percentage of the public water supply is drawn from Otisco Lake, which is within the Nine Mile Creek and Onondaga Lake watersheds.

The Metro facility was designed to provide advanced secondary treatment for biochemical oxygen demanding- material (BOD) and phosphorus removal for sewage flows of up to 120 mgd. Discharge to Onondaga Lake is through a surface outfall. Flows between 120 mgd and 220 mgd undergo primary treatment and chlorination prior to discharge to Onondaga Lake via a separate outfall.

3.1.3 Land Use

The Onondaga Lake watershed is highly urbanized compared with other lakes in the Oswego River Basin. Approximately 22% of the basin is classified as urban, 43% as forest, 32% as agricultural and 3% as other. Table 1 provides a breakdown of land-use categories by subwatershed, using the National Land Cover Data (NLCD) classification. These data, presented in the Onondaga Lake Ambient Monitoring 2000 Annual Report and provided by the Syracuse Onondaga County Planning Agency (SOCPA), are based on the Multi-Resolution Land Characterization (MRLC) Consortium's Landsat 5 Thematic Mapper satellite data, last updated July 2000.

During the late nineteenth century, Onondaga Lake was the focus of a flourishing resort industry. The lake became increasingly degraded as the population grew and industries developed and its uses became impaired. Completion of the Onondaga County Metro wastewater treatment plant in the late 1960s and the banning of phosphorus detergents in the early 1970s marked the beginning of significant efforts to bring about lake recovery.

Improved technology and more stringent regulations led to the reduction or elimination of some point sources of pollution. The level of treatment provided for municipal and industrial waste discharges has increased over the past decades. The Metro treatment plant was upgraded to secondary treatment in 1978 and advanced secondary in 1981. In 1993, the Metro facility underwent structural modifications to its aeration tanks, clarifiers and anaerobic digesters to improve performance. Following completion of the structural modifications, the Metro operations staff has continued to improve performance of the treatment plant through operational adjustments. Reduction in the concentrations of phosphorus and ammonia-N in Metro effluent have resulted from the enhanced operation. Nitrification has increased with improvements to the plant's aeration facilities. The treatment plant is currently being upgraded and expanded to provide year-round nitrification and enhanced phosphorus removal.

Portions of the City of Syracuse have combined sewers, single pipes that convey both wastewater and stormwater to the Metro facility. When pipe capacity is exceeded during rainstorms and snowmelt, a mixture of stormwater and untreated wastewater discharge to Harbor Brook, Ley Creek or Onondaga Creek through overflow points in the sewer system (called combined sewer overflows or CSOs). The frequency and volume of discharge from the CSO network was reduced in 1984 with implementation of a best management practices program. However, overflows continue to occur multiple times each year and have an adverse impact on the water quality and aesthetics of the streams and lake. Under typical rainfall conditions CSOs are projected to occur over 50 times each year (Moffa & Associates, 1994). The engineering improvements now underway are designed to mitigate these overflows and bring the County's wastewater collection and treatment system into compliance with state and federal regulations.

Nonpoint sources of nutrients, sediment and bacteria enter Onondaga Lake through the tributaries and CSOs. Industrial residuals such as metals and PCBs enter Onondaga Lake through individual tributaries. For example, PCBs in the Ley Creek basin from historical activities, and chloride from the Honeywell (formally Allied Signal) waste beds in the Nine Mile Creek basins, continue to flow to the lake through surface runoff and infiltrating groundwater. Lake sediments contain elevated concentrations of mercury and organic chemicals.

Agricultural Setting Description

The Onondaga County Soil and Water Conservation District (SWCD) conducted the Onondaga Lake Rural Nonpoint Source Assessment in conjunction with United States Department of Agriculture-Natural Resources Conservation Service in 1992. The farms must meet the agricultural assessment of full-time status to be included in the survey. One criterion is that the farm must gross $10,000 a year for minimum of 2 years to be considered full-time. The assessment counted a total of 107 farms in the Onondaga Lake watershed. The land use is 37,181 cropland acres including 3,721 acres of pastureland. A total of 67 dairy farms were counted.

The 2002 SWCD estimate of farms of all types in the Onondaga Lake watershed was further broken down by subwatershed. The current numbers of farms for each subwatershed are:

- 36 in Onondaga Creek

  30 in Otisco Lake (which drains into Nine Mile Creek)

- 30 in Nine Mile Creek (in additional to Otisco Lake farms)

- 2 in Harbor Brook

- 0 in Ley Creek

City of Syracuse SW Drainage Description

The City of Syracuse, located in Onondaga County, is the region's major metropolitan center, encompassing approximately 20 square miles. The City of Syracuse together with the adjacent towns and villages have been designated an urban area by the State of New York, and thus fall under the Phase II stormwater regulations. The urban area including the City of Syracuse is approximately 100 square miles and includes the towns and villages identified in Table 2. The area is illustrated in Figure 3.

Combined sewers service approximately one-half the City of Syracuse area (10 square miles);

separate sanitary sewers and stormwater sewers service the other half. None of the surrounding towns or villages, as identified in Table 2, has combined sewers. These towns and villages use either separate sanitary sewers or septic systems for wastewater, and all have some type of stormwater collection and discharge system.

Onondaga County is responsible for the combined sewer system in the City of Syracuse. The County is currently implementing a CSO program designed to minimize the impacts of CSO to Onondaga Lake. This program is estimated to cost $144 million and is proposed to be completed by 2012, based on current design and implementation schedule, which may be subject to change (Onondaga County, 2002). The City of Syracuse is responsible for the stormwater system (excluding the CSO area) and maintains all the street drainage basins (catch basins) within the City of Syracuse.

The City of Syracuse and the surrounding municipalities are required to develop a stormwater program addressing the following:

- Reduce the discharge of pollutants to the "maximum extent practicable" (MEP)
- Protect water quality
- Satisfy the appropriate water quality requirements of the Clean Water Act

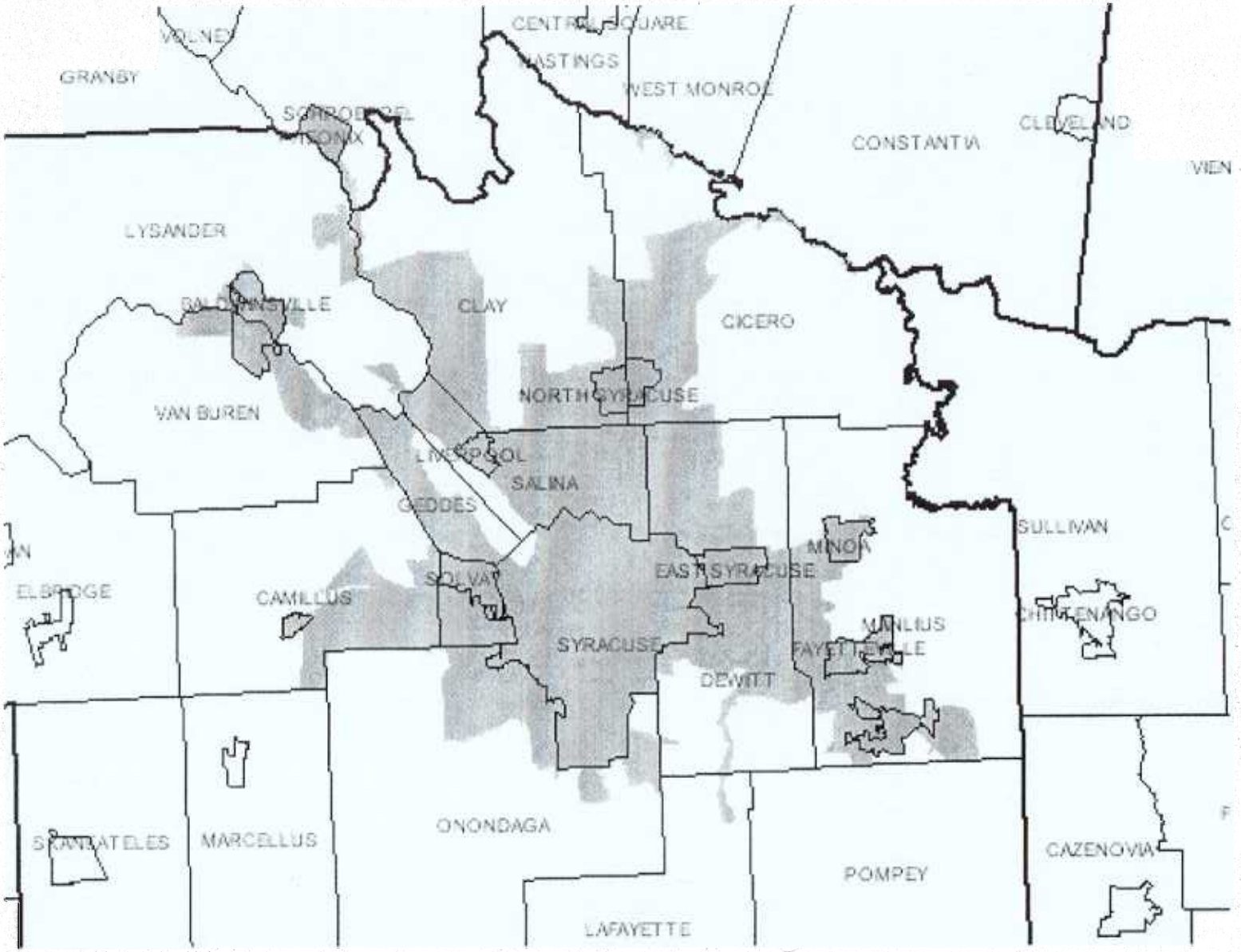
Land classification	Geddes Brook	Harbor Brook	Ley Creek	Nine Mile Creek	Onondaga Creek	Onondaga Lake	Otisco Lake
open water (11)	0.3%	0.4%	0.0%	0.3%	0.1%	28.7%	8.6%
low intensity residential (21)	26.8%	28.7%	19.7%	4.7%	5.7%	24.3%	0.5%
high intensity residential (22)	4.1%	14.2%	14.5%	0.4%	5.2%	6.8%	0.0%
commercial/industrial/transportation (23)	4.2%	3.0%	24.2%	2.1%	2.8%	12.9%	0.2%
quarries/strip mines/gravel pits (32)	0.1%	0.0%	0.0%	0.3%	0.2%	0.1%	0.0%
deciduous forest (41)	32.2%	19.6%	18.7%	38.7%	30.3%	14.5%	33.5%
evergreen forest (42)	0.2%	0.2%	0.1%	0.1%	0.6%	0.0%	0.6%
mixed forest (43)	4.0%	5.5%	3.9%	4.1%	21.5%	1.0%	14.2%
pasture/hay (81)	17.3%	20.6%	6.9%	38.2%	25.6%	3.4%	34.6%
row crops (82)	5.1%	2.8%	2.9%	7.5%	6.7%	0.7%	7.1%
urban/recreational grasses (85)	4.9%	5.0%	8.8%	2.2%	0.9%	6.9%	0.3%
woody wetlands (91)	0.7%	0.2%	0.2%	1.2%	0.5%	0.6%	0.6%
emergent herbaceous wetlands (92)	0.0%	0.0%	0.1%	0.15%	0.0%	0.1%	0.0%

Note: Geddes Brook, Nine Mile Creek and Otisco Lake subwatersheds are part of the entire Nine Mile Creek watershed.

Source: EcoLogic LLC, 2001. Onondaga Lake Ambient Monitoring 2000 Annual Report to Onondaga County, Syracuse, NY. Data provided by the Syracuse Onondaga County Planning Agency (SOCPA), are based on the Multi-Resolution Land Characterization (MRLC) Consortium's Landsat 5 Thematic Mapper satellite data, last updated July 2000.

Towns, Cities and Villages within Syracuse Urbanized Stormwater Area

- Baldwinsville (V)
- Camillus (T)
- Camillus (V)
- Cicero (T)
- Clay (T)
- De Witt (T)
- East Syracuse (V)
- Fayetteville (V)
- Geddes (T)
- LaFayette (T)
- Liverpool (V)
- Lysander (T)
- Manlius (T)
- Manlius (V)
- Minoa (V)
- North Syracuse (V)
- Onondaga (T)
- Salina (T)
- Solvay (V)
- Syracuse (C)
- Van Buren (T)



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Syracuse Urbanized Stormwater Area

Figure 3

4 EBP SELECTION/DESIGN

4.1 Approach to Selecting Agricultural BMPs

The EBP selection and design process used a combination of newly established approaches and efforts that were customized to fit the nature of the project. A general review of farms within the watershed was made to meet several basic criteria before investing significant resources into the site investigation specific to each participating farm. The general criteria included:

- Location in watershed and subbasin
- Size and type of farming operation
- Degree of water quality pollution risk
- Likelihood of farmer to participate in project
- Likelihood of farmer to operate and maintain installed BMPs
- Willingness of farm operator to permit access, sampling of water quality and tours on the farm premises

The farmers agreed to participate in the project after raising relevant questions about the use of information discovered in the course of the project implementation. A general lack of understanding, mistrust and fear of regulation exists among the farming community. There was concern among all farms about possible state enforcement action against the farm if there were found to be water quality problems. This was to be expected, since at the time of project initiation, the Confined Animal Feeding Operation (CAFO) law was not yet in place and only voluntary programs were in existence to deal with agricultural sources of water pollution. During the project the Leubner Farm applied for and received a CAFO permit due to the size of their operation. The other farms were not of sufficient size to fall under CAFO.

The farmers were assured that no enforcement action would be initiated based on the results of this project. The farmers also agreed to have their farms serve as demonstration sites for other farmers, regulators, planners and other relevant groups. This agreement was easier to make since the structural improvements to address water quality risks would be made at no cost or nearly no cost to the participating farms.

The process of selecting specific BMPs continued by first making a series of visits to the farms and walking the farmstead and attached farm property. Sketches were developed to confirm location of buildings, areas of animal concentration, feed storage, ditches, pipes, streams,

intermittent water courses, wells and other relevant features. Interviews were conducted with the farm operators to identify their understanding of water quality risks, understanding of water quality impacts and specifics about their farm operation. Aerial photos of the farms, where available, were compared to current conditions.

Follow-up visits were made to the farm and project team members completed Tier I and II Assessments from the Agricultural Environmental Management (AEM) guide for New York State. The tiered assessment process was developed in 1997 by several organization as listed below:

- NYS Department of Agriculture and Markets (DAM)
- Cornell Cooperative Extension

  NYS DEC
- NYS Department of Health
- NYS Soil and Water Conservation Committee
- Skaneateles Lake Watershed Agricultural Program
- USDA Natural Resources Conservation Service

Assessments were designed to provide a coordinated, science-based, farmer-friendly approach to addressing environmental concerns of agricultural operations (NYS DAM, 1997).

The AEM process was geared towards identifying priorities for investment of public funds, education of farm operators and the creation of "whole farm plans," which create a comprehensive economic and environmental strategy for farm management. Tier I questionnaires and Tier II worksheets function to identify and assess the basic conditions and risks on the farms. Numbers of animals, manure spreading practices, fertilizer and pesticide use and farmer's business objectives are some of the covered topics. Tiers III to V include more detailed plans, solutions, farm business planning, BMPs and evaluation of progress.

The EBP project team completed Tiers I and II with the farmers as part of the EBP selection process. The team did not proceed to Tiers III to V since the objectives differed from those of the Soil and Water Conservation District; the EBP project was confined to farmstead-scale problems and remedies and not geared towards long-term soil management efforts. Completion of Tiers I and II was useful for several reasons:

- Confirmation of the risks we had identified through site visits and farmer interviews

- Standardization of an assessment method used on all three farms
- Initiation of the AEM process for the farms with information that could be shared with the SWCD for future projects

The site assessment and AEM work led to the selection of sites for the implementation of BMPs. Design of the selected BMPs preceded with topographic land surveys, which provided necessary measurements for sizing and location. Design drawings and specifications were then produced. Drawings were revised to the satisfaction of the farmers. Efforts were made to have all BMPs comply with Natural Resources Conservation Service (NRCS) specifications. BMPs such as "surface barkfilters" do not have an NRCS specification but have been used by the Onondaga County Soil and Water Conservation District (OCSWCD) under the guidance of provisional standards in other states and technical papers from Cornell University. The New York State NRCS does have a "subsurface barkfilter" specification, formally known as the Milkhouse Wastewater Infiltration Area (NY719) conservation practice; this type of barkfilter was not constructed as part of this project.

Work plans and drawings were made available as bid documents to contractors to submit bids for the on-farm improvements. Bid documents were designed in an itemized format for each work task. This allowed the project team to list and prioritize potential BMPs. After cost estimates were returned from contractors, the project team was able to select the priority BMPs that could be completed within the available budget.

Selected Agricultural BMPs

The selected agricultural BMPs were implemented starting in 1999, with the 2000 construction season as the primary implementation period. Some additional implementation steps occurred in 2001. The project team was able to construct and implement the majority of the desired BMPs with the available budget. Additional BMPs were identified on each farm as recommendations for future work, either through the SWCD, this EBP project or another program. A simple principle was maintained throughout implementation of BMPs: keep the clean runoff clean and divert the contaminated runoff to a treatment area.

Rohe Farm

The Rohe Farm represents a typical family-owned, 100-head dairy farm that plans to continue operations as usual. The barnyard, feeding and primary pasture areas are adjacent to an intermittent stream tributary to Harbor Brook. Figure 4 depicts these areas and the implemented BMPs.

Table 3 identifies the water quality risks initially found at the Rohe Farm and the implemented

BMP solution. Design drawings are presented in Appendix A.

4.2.2 Guptill Farm

The Guptill Farm currently raises beef cattle and houses heifers from other dairies, totaling over 100 head of livestock. Barnyard, livestock feeding areas, manure spreading fields and pastures are located adjacent to a tributary of the west branch of Onondaga Creek. Figure 5 depicts these areas and the implemented BMPs. The farm property is typical of various trends within the agricultural industry. The farm left the milking aspect of the dairy industry in 1992 due to low milk prices and has transitioned towards other agricultural activities: beef cattle, certified organic products, cropping and composting. The farm owner has demonstrated a commitment to improving environmental management through voluntarily enrolling in the transition period to organic certification. This includes the elimination of pesticides and chemical fertilizer used on crops, primarily corn.

Table 4 identifies the water quality risks initially found at the Guptill Farm and the implemented BMP solution. Design drawings are presented in Appendix B.

4.2.3 Leubner Farm

The Leubner Farm is typical of many dairy farms in New York State. Recently the farm has expanded from 150+ head of livestock to over 400 head of livestock (milking cows and young stock). The farm also grows corn, hay and a significant amount of pumpkins. The veal-calf operation has recently expanded from 50 to 200 head on a portion of the farmstead outside the tributary basin that was monitored for the EBP. The farm is large and covers several watersheds including Onondaga Lake. The farmstead, including the primary barns, barnyard, feed storage and manure handling areas, are in the Nine Mile Creek watershed. Figure 6 depicts these areas and the implemented BMPs. These farmstead areas drain into a roadside ditch, which flows to a tributary stream that joins Nine Mile Creek north of the Otisco Lake dam.

Table 5 identifies the water quality risks initially found at the Leubner Farm and the implemented BMP solution. Design drawings are presented in Appendix C.

4.3 Selected Urban BMPs

Two urban BMPs were selected for this project; namely a stormwater vortex unit and a vegetative filter strip. These BMPs represent a structural and nonstructural approach, respectively.

4.3.1 Stormwater Vortex Unit

A stormwater vortex unit was selected to represent a structural approach to controlling and treating urban stormwater.

A stormwater vortex unit is a device designed to capture settleable solids (solids such as grit and sand that settle in quiescent flow), floatables, oils and grease and incidental nutrients from stormwater runoff. The stormwater vortex unit consists of a concrete cylindrical vessel that can be installed in place of an existing catchbasin. Stormwater enters tangentially into the cylindrical vessel, which creates a circular flow path (i.e. vortex). This circular flow path minimizes turbulence and allows solids to settle into an isolated storage zone (depending on configuration) and not become re-entrained. Stormwater vortex units are generally baffled to enhance floatable and oil and grease collection. These units collect and store pollutants in the cylindrical vessel during a stormwater event, and the pollutants are removed from the unit after the stormwater event has ended.

Several companies that manufacture stormwater type vortex units provided information. A summary of information provided by these companies can be found in Appendix D. This information was provided to the City of Syracuse engineers and the project team, with the approval from the city engineers, selected the Downstream Defender® manufactured by H.I.L. Technologies (Hydro International).

The City of Syracuse engineers originally recommended two sites for the stormwater vortex unit:

1 205 Hopper Road, Syracuse, NY 13207

2 201 East Seneca Turnpike, Syracuse, NY 13205

The site on East Seneca Turnpike was selected. After field reconnaissance the actual location of the unit was moved approximately 150 feet to the west to 134 East Seneca Turnpike. This area is depicted in Figure 7.

Due to budget constraints and sampling objectives, a 4-ft diameter Downstream Defender® with a design flow rate of 0.75 cfs was purchased for installation at the East Seneca Turnpike site, which has a catchment area of approximately 1.2 acres. Hydro International recommends a conservative approach to sizing the Downstream Defender® if no regulatory guidelines are available as in New York State. It is typically recommended to size the installation so that the design flow of the unit is greater than or equal to the peak runoff rate from a 1-year, 24-hour storm event as a minimum, with a 2-year, 24-hour storm event desirable. This conservative approach is taken because of the variability related to the first flush and TSS size distributions and particle densities.

For this project, the project team sized the Downstream Defender® much more aggressively than recommended by Hydro International. The sizing rationale for this site was based on exceeding the design flow rate of 0.75 cfs at least once or twice a month. This approach was taken in order to increase the likelihood that the site would generate flows at or above the design flow and thereby generate performance data at and beyond the unit's design flow. Design drawing for the Downstream Defender® can be found in Appendix E.

Once the Downstream Defender® was located and designed, applications were submitted to the City Common Council for approval. The council adopted Ordinance No. 327 on July 10, 2000, which granted permission for the project team to construct and install the Downstream Defender®. A letter of approval can be found in Appendix F. Additionally, during field reconnaissance several residents stopped to discuss the purpose of the work and the potential impacts to their street.

4.3.2 Vegetative Filter Strip

A vegetative filter strip was selected to represent a non-structural approach to controlling and treating urban stormwater.

Vegetative filter strips are constructed strips of vegetation used in various settings to remove pollutants in stormwater runoff from a developed site. Vegetative filters are constructed in areas where stormwater runs off the surface as sheet flow. A vegetative filter can have a heterogeneous mix of ground cover, including herbaceous and woody species of vegetation or a homogenous cover of grass. Vegetative filters are variable in size and are designed to remove sediment and other pollutants from surface water runoff by filtration, deposition, infiltration, absorption, decomposition, and volatilization.

During the work plan development phase it was proposed to construct a vegetative filter strip on the down gradient end of a parking lot. Similar to the stormwater vortex unit, the City of Syracuse engineers recommended sites for the vegetative filter strip. The proposed parking lot sites were:

1. Thornden Park (near Syracuse University)
2. Burnet Park Zoo
3. Syracuse University C lots (between the Carrier Dome and Rt. 81)

The major challenge in selecting a site was the unwillingness of the parking lot operator to give up any parking spaces, and ultimately none of the operators would give up parking spaces. This presented a challenge because the parking spaces encroached within feet of the property line, thus leaving no space for a vegetative filter strip. In the end, the selected site was at the Burnet

Park Zoo, where it was proposed to convert a cobblestone-lined ditch at the down gradient end of a parking lot into a vegetative filter strip. A letter of authorization from Anne Baker, Zoo Director, is presented in Appendix G. This letter briefly discusses the objectives and work plan for implementing the vegetative filter strip.

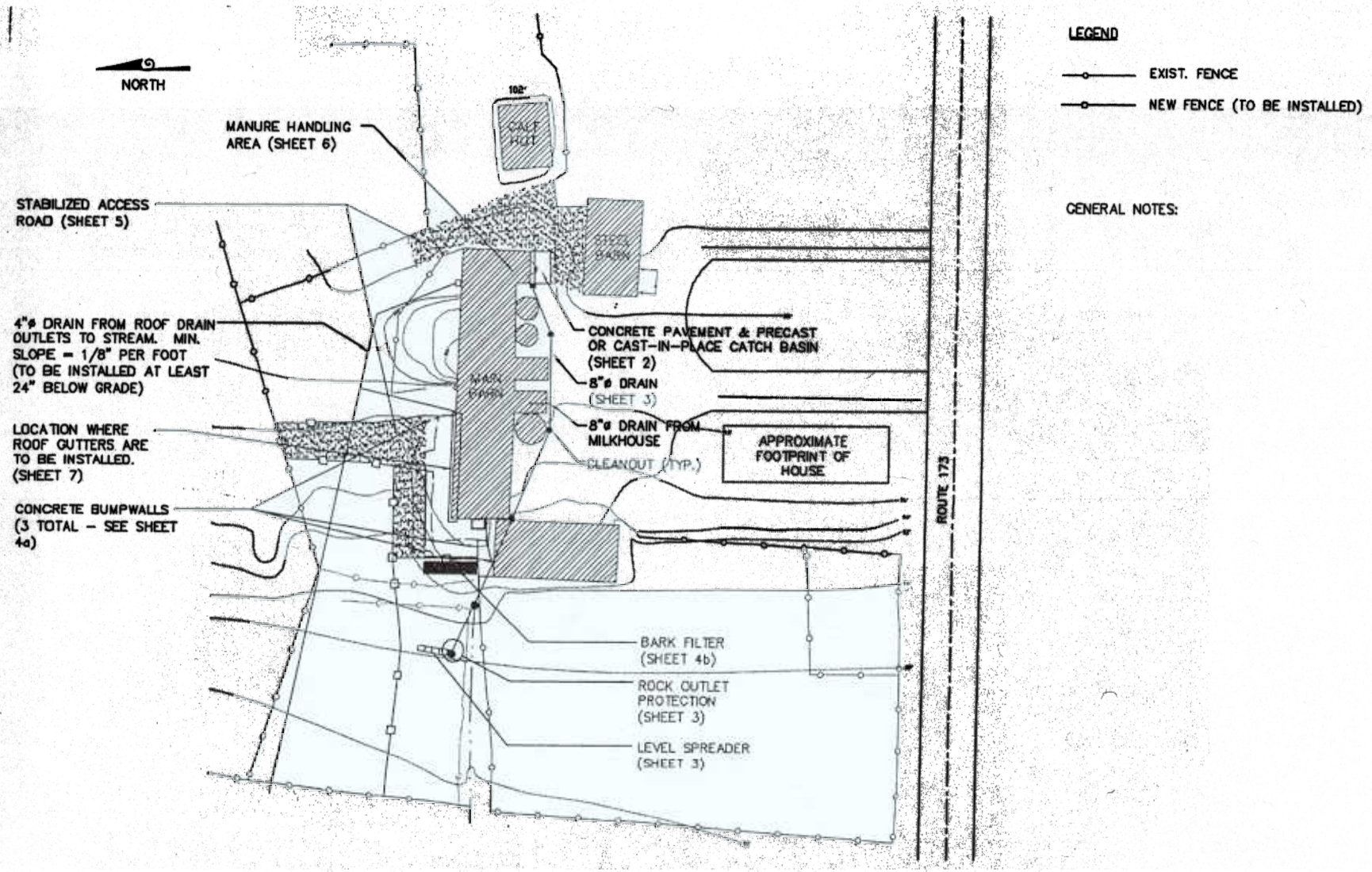
The original stormwater structure in the zoo parking lot was a 160-foot, cobblestone-lined ditch, which was constructed around 1985 for stormwater conveyance, not treatment. The width of the ditch was approximately two feet, but there was approximately four feet of available land to one side of the ditch for which to expand the vegetative filter strip. Figure 8 depicts this area. The existing ditch failed to function properly as a stormwater conveyance system because it continually filled with sediment, which caused a berm to form at the edge of the parking lot resulting in a short-circuiting of the ditch.

The catchment area to the vegetative filter strip was surveyed and the stormwater flow and volume were calculated. The vegetative filter strip area was sized to allow the minimum possible flow velocities and to provide some water ponding during wet-weather event to maximize infiltration. In turn, a new vegetative filter strip was designed and constructed to collect and convey runoff from the parking lot. Installing the vegetative strip entailed removing the existing cobblestone stormwater conveyance system and reshaping the area to promote grass establishment, water conveyance and the percolation of runoff. Native grasses were planted for maximizing survival and pollutant removal. Design drawings are presented in Appendix H.

Water Quality Risk	BMP Solution
Accumulated manure solids in stream	• Excavated manure solids from stream and applied to fields
Milk house wash water discharged to stream through a pipe	• Intercepted wash water and applied to vegetative strip using a level lip spreader
Manure handling station runoff discharged to stream through a pipe	• Prevented run-on to station by intercepting clean roof water and polluted surface water • Conveyed clean roof water directly to stream • Intercepted polluted surface water and applied to vegetative strip using a level-lip spreader
Manure liquids (urine) and solids from manure handling discharged to stream through a pipe	• Intercepted manure liquids (urine) and solids using a sump pit and pump in the manure handling station • Liquids and solids pumped into spreader and applied to fields
Unstablized barnyard area with drain tile to stream	• Stablized barnyard with a concrete pad with bump walls for cleaning • Contained animals in barnyard with fencing, which separated the animals from the stream edge • Intercepted barnyard runoff with barkfilter • Disconnect drain tile
Clean roof water falling on barnyard area	• Intercepted clean roof water with eve troughs and conveyed water directly to stream
Animal pasture/loafing area near stream	• Created a buffer zone with fencing and stablized walkways to pastures further from the stream • Stablized walkways with geotextile and compacted stone dust

Water Quality Risk	BMP Solution
Animals loafing and feeding exclusively in the stream bed	• Excluded animals from streambed by developing a rotational grazing system. The system requires the rotation of the cattle to each fenced pasture section to avoid vegetation damage, soil erosion and sedimentation and manure concentrations • Seeded pastureland so that fields provided sufficient vegetation to support the livestock • Installed fencing and stablized walkways as part of rotational grazing system • Installed concrete pad feed area with bump walls and barkfilter. This allowed for the exclusion of livestock from areas during portions of the year when livestock traffic could damage vegetation and result in soil erosion and sedimentation. The area allows for year-round access and runoff control of water from the feeding area. A bark filter and vegetated filter strip treats the runoff from the feeding pad • Developed alternative water supply for pasture system • Stablized streambed area with grasses and trees. Trees and new grass were planted in formerly disturbed areas and at the edges of pasture areas. The new grass and trees should further stabilize soil and provide future benefits to the pastures by creating shade and windbreaks

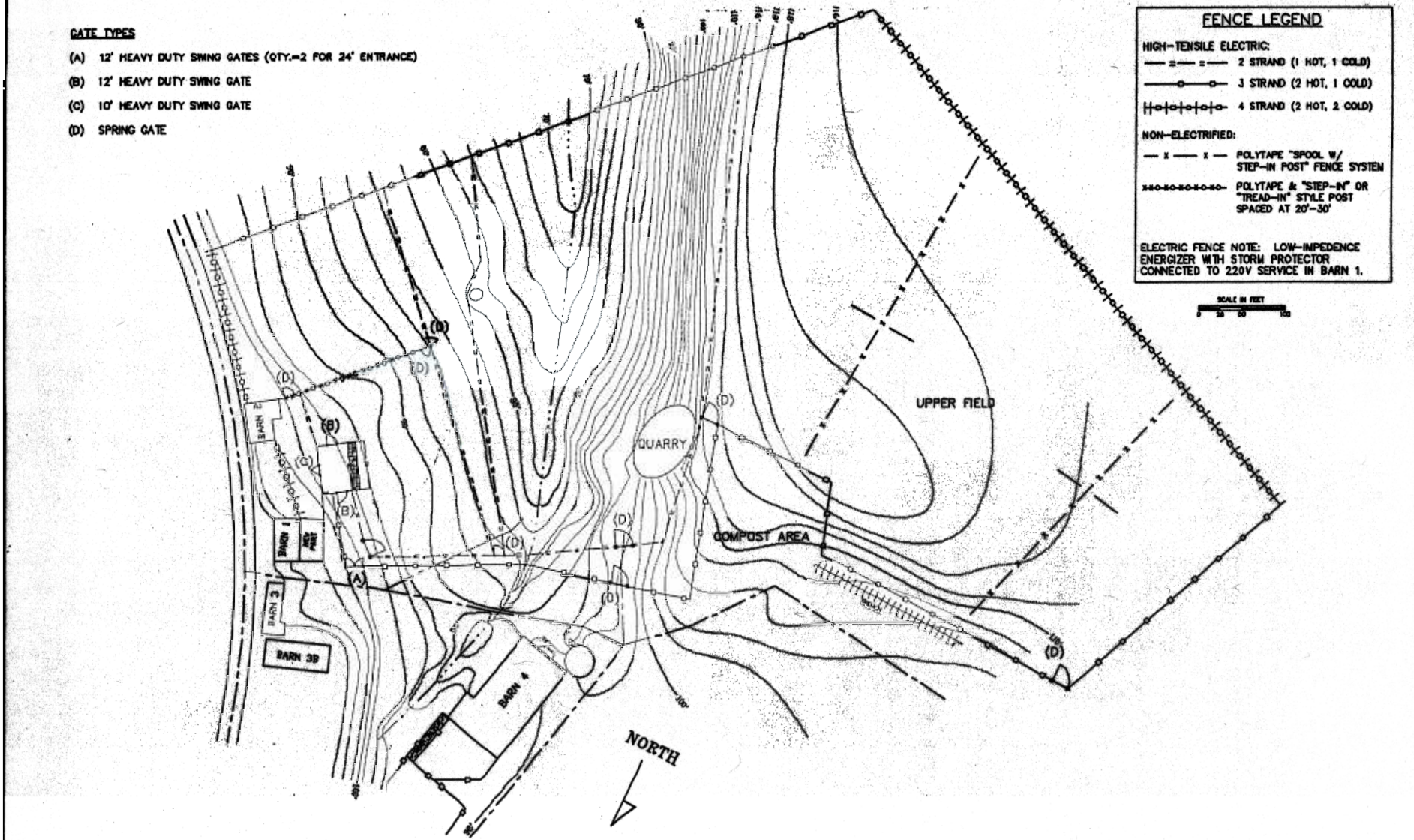
Water Quality Risk	BMP Solution
Animals loafing and pasturing adjacent to stream in field with drain tile	• Excluded animals from field through converting field to hay lot, which created a buffer zone between active barnyard area and stream
Manure handling station runoff discharged to areas with drain tile	• Prevented run-on to station by intercepting clean roof water and polluted surface water • Intercepted clean roof water with new eve troughs, new drip drains and improved existing drip drain and conveyed directly to stream • Intercepted polluted surface water and applied to barkfilter and vegetative strip using a level-lip spreader
Poor control and containment of manure at manure handling station	• Improved containment of manure by enlarging manure handling station and constructing concrete containment/bump walls
Silage leachate and runoff discharged to stream through a pipe	• Intercepted leachate and runoff and applied to barkfilter and vegetative strip using a level-lip spreader



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Site Layout with BMPs

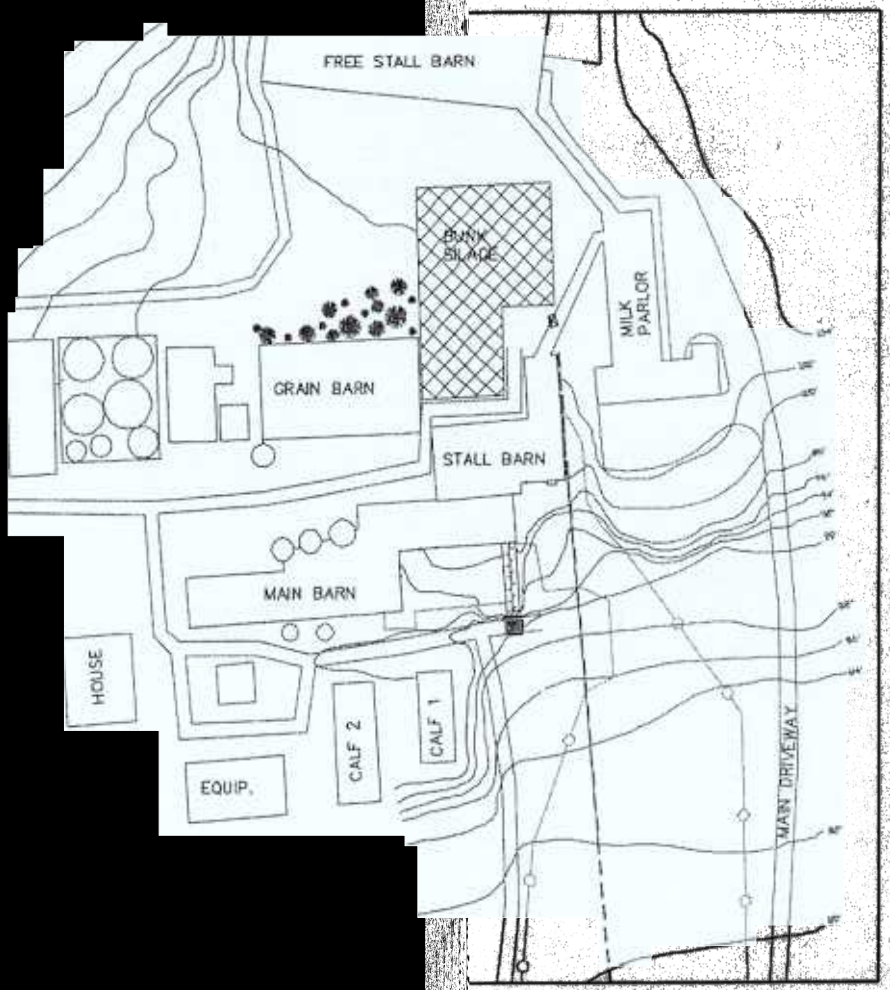
Figure 4



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Site Layout with BMPs

Figure 5



OUT

200

Source EBP
t BMPs

Figure 6

Moffa & Associates
A unit of Brown and Caldwell

CONTRACT DRAWINGS

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

EAST SENECA TURNPIKE DOWNSTREAM DEFENDER
ONONDAGA COUNTY, NEW YORK

CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT BOARD

INDEX OF DRAWINGS

DD-1 AREA MAP (TITLE SHEET)
DD-2 LAYOUT DETAILS
DD-3 MANHOLE DIVERSION DETAILS
DD-4 GENERAL ARRANGEMENT DETAILS

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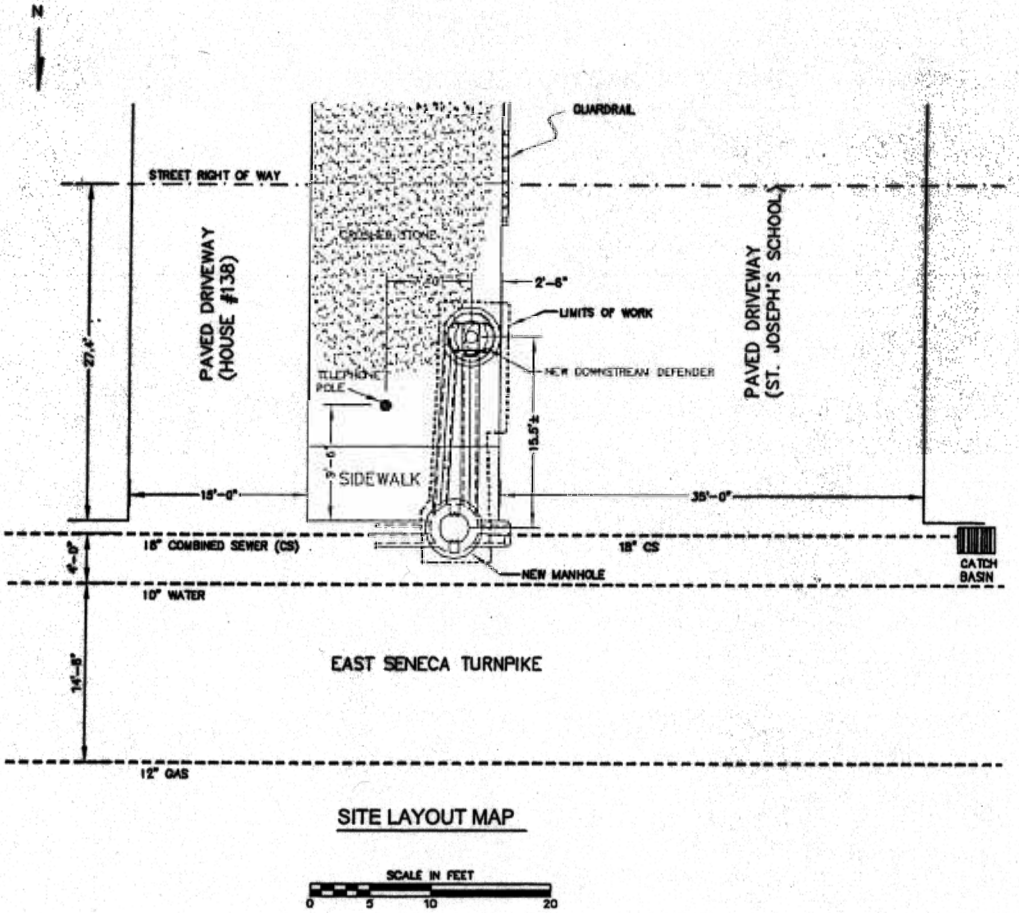

SITE LAYOUT MAP

SCALE IN FEET
0 5 10 20

CONTRACT DRAWINGS

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

VEGETATIVE FILTER STRIP AT BURNET PARK ZOO
ONONDAGA COUNTY, NEW YORK

CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT BOARD

LOCATION PLAN
BURNET PARK ZOO
1 CONSERVATION PLACE
SYRACUSE, NY 13204

INDEX OF DRAWINGS

SHEET 1: EXISTING AND PROPOSED SITE PLANS
SHEET 2: EXISTING AND PROPOSED SECTIONS
SHEET 3: MISCELLANEOUS LOCATION PLANS

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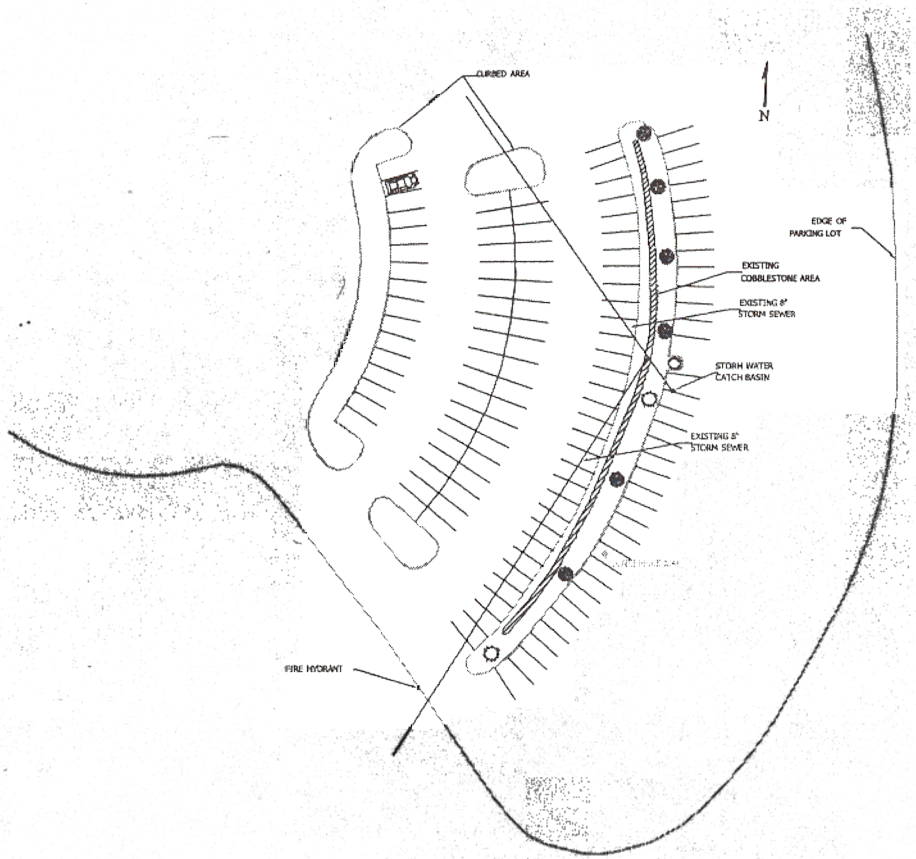


Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Burnet Park Zoo Parking Lot with Cobble Stone Lined Ditch

Figure 8

5 EBP IMPLEMENTATION

5.1 Agricultural BMPs

Implementation on the three farms proceeded after selection of contractors through a competitive bid process. The project team continually reviewed the work of the contractors, interviewed the farmers and made numerous site visits. The work was completed slightly behind schedule and slightly under budget.

5.1.1 Rohe Farm

Implemented BMPs include:

Removal of Manure Solids from Intermittent Stream Tributary to Harbor Brook. Manure solids had accumulated in the intermittent stream tributary to Harbor Brook over the years due to poor manure handling practices. It is likely that these accumulated solids were a major source of nutrients from the farmstead and would have likely contributed more nitrogen and phosphorus to the water quality samples. The solids were removed before June 25, 1999, before the second pre-BMP sampling date. These solids, approximately 300 yards, were removed with a backhoe and spread on fields for disposal.

Barnyard Improvements. The barnyard is adjacent to an intermittent stream tributary to Harbor Brook. The runoff from the barnyard has high concentrations of phosphorus, nitrogen and sediments. Overland flow reaching the intermittent stream originated from the concrete pad outside the main barn as depicted in Figure 9. In its original condition it was difficult to clean and when it was cleaned, manure solids were scraped off the edge of the concrete pad onto the ground where a tile drainpipe is buried. The original condition of the barnyard is depicted in Figures 10 and 11.

The improvements to the barnyard included surface stabilization and curbing so that the area could be periodically scraped and cleaned to reduce the amount of manure runoff and sedimentation. Bump walls were constructed for the purpose of scraping manure with a front-end loader. The barnyard and fencing were constructed to avoid injuries to animals returning for milking. A bark filter was constructed at the down gradient end of the new concrete pad. The purpose of the bark filter is to entrap manure solids and act as a nutrient sink. The area between the new concrete pad/bark filter and the intermittent stream is now vegetated. No animals are allowed to graze on this vegetation; the area acts as a buffer between barnyard activity and the intermittent stream. These improvements are illustrated in Figures 12 and 13.

Manure and Milk House Waste Management Improvements. The manure handling station and milk house are not directly adjacent to the intermittent stream tributary to Harbor Brook; however, drain pipes from these areas were directed towards the brook. The runoff from these areas has high concentrations of phosphorus, nitrogen and sediments. The improvements to these areas included reducing runoff and redirecting the drainage pipes from the brook to the vegetative filter strip that is part of the barnyard improvements.

Originally, during normal operation, manure liquids drained from the conveyor, flowed over the floor and drained into the sump at the edge of the barn. This sump drained to an area near the concrete pad at the main barn and flowed overland into the intermittent stream. During rain events, runoff from the driveway entered the manure barn, mixed with the manure liquids and flowed into the overflow drain and ultimately to the intermittent stream. The original manure handling station is depicted in Figure 14.

Improvements included stabilizing the area outside the manure barn and intercepting runoff with a catch basin before it entered the barn as illustrated in Figure 15. This water is then conveyed to a level-lip spreader upgradient of the vegetative filter strip. Improvements also included constructing a sump pit with a pump in the manure barn to collect the manure liquids. The manure liquids are then recombined with the manure solids in the manure spreader, for subsequent application to the fields. The new sump pit is illustrated in Figure 16.

Drainage Improvements. Before BMP implementation, the general drainage practice for this farm was to pipe the runoff directly to an intermittent stream tributary to Harbor Brook. During BMP implementation the approach was to separate the clean water from the impacted water, convey the clean water to the brook and control and treat the impacted water.

During construction some tile drains were disconnected from their discharge to the intermittent stream. Figure 17 shows a poorly drained area at the end of a culvert. Cows would walk through this area and vegetation was not able to grow. A new catch basin and concrete pad were installed. Cow traffic was diverted around this area to a new area stabilized with gravel. The pipe from the catch basin discharges into the field and not directly into the intermittent stream. The new catch basin is illustrated in Figure 18.

There were three major improvements made during construction that were not in the original contract drawings. The first was the expansion of the stabilized concrete barnyard. The Rohe Farm paid for this additional work because it was to the benefit of farm operations as well as water quality. The second additional improvement was to move the level-lip spreader further away from the stream and closer to the bark filter, thus offering more vegetative strip treatment area. This was possible because the pipe that discharges into the level-lip spreader from the millhouse and manure handling station was installed at a higher elevation than originally designed. The third modification included improvements to the drainage in front of the dry cow

barn as depicted previously in Figures 17 and 18.

5.1.2 Guptill Farm

Implemented BMPs include:

Rotational Grazing. Originally, the actual streambed and surrounding riparian area were used for cattle pasturing and feeding. The farmer chose this area because of its water supply and shade qualities. Improvements included removing the animals from the streambed and riparian areas and developing an alternative area for pasturing and feeding.

The original pasturing practice allowed nutrients from manure and feed to reach the creek through direct cattle to water contact and from the cattle feeding station adjacent to the edge of the stream. Soil erosion into the creek was obvious; cattle grazing had denuded the streambed and cattle traffic destabilized the soil surface as depicted in Figure 19. Excluding the cattle from the streambed was the highest priority on this farm. Alternative farming techniques, such as rotational grazing were implemented in order to exclude the cattle from this streambed. Figure 20 shows part of a newly fenced pasture. The rotational grazing pastures were implemented with alternative water and shade sources. Once the animals were removed from the streambed area the area was revegetated with tall fescue and reed canary grasses. The revegetated area is illustrated in Figure 21.

Stabilized Concentrate Feed Area. The farm did not have an area dedicated to feeding the cattle; instead a feed wagon was moved around the streambed area. This practice tended to concentrate the animals near the stream and spoiled feed would remain in the streambed area. Improvements included constructing a new concrete feed area with bark filter and vegetative buffer strip.

The concentrated feed area was constructed approximately 200 feet from the streambed. It consists of a concrete pad, bark filter and vegetated buffer strip. Figures 22 and 23 show the concentrated feed area. Figure 23 also shows a portion of the rotational grazing system, including a stabilized walkway from one paddock to another. A bark filter was constructed at the down gradient end of the new concrete pad. The purpose of the bark filter is to entrap manure solids and act as a nutrient sink. The area down gradient of the new concrete pad/bark filter was vegetated. No animals are allowed to graze on this vegetated buffer strip. The area will act as a buffer between feeding activity and the creek.

In general, agricultural BMP implementation at the Guptill farm progressed as planned. The only major field change related to the water supply. The originally designed alternative water system relied on developing ground and spring water resources on the farm. During the period after design, but before construction, the Guptill Farm learned of a municipal water system being

extended into the area. It was decided that connecting into the municipal system was more reliable; however it was more expensive. The Guptill Farm shared the difference in cost between the original water system and the connection to the municipal system.

5.1.3 Leubner Farm

Implemented BMPs include:

Manure handling station (run-on and runoff control). The original manure handling station was impacted by wet weather conditions and had poor access. During storm events and wet periods, water would run over the manure handling area, transporting nutrients and solids into the drainage area of the roadside ditch and tributary stream. There were tile drainpipes in this area that would aid in transporting nutrients and solids into the drainage area of the roadside ditch and tributary stream. The improvements to the manure handling station included reducing the amount of run-on, improving the usability of the manure handling station and disconnecting the tile drainpipes that discharged to the roadside ditch.

The original manure handling station was poorly drained and therefore difficult to use and clean. Manure solids and associated nutrients accumulated around the manure handing station and eventually reached the roadside ditch and tributary stream area through drainage pipes and overland flow. The original manure handling station is illustrated in Figure 24.

Improvements included installing new concrete walls around the existing manure handling pad to facilitate manure clean up. A concrete chute was constructed to convey drainage from the manure ramp to the bark filter. These improvements are illustrated in Figures 25 and 26. These figures also show the bark filter that collects runoff from the manure-handling pad.

Vegetative Buffer. The field immediately upgradient of the roadside ditch and tributary stream received regular applications of manure, fertilizer and composted biosolids. This area was also mostly denuded and used as an animal loafing area (concentrated animal area). Improvements included establishing a vegetative buffer area that would slow water movement from the active barnyard area and trap nutrients and sediment. An area in this vegetative buffer area was also specially graded and seeded to receive runoff from the feed bunk, which is a major source of concentrated nutrients.

In the past, animals grazed on the field just upgradient of the roadside ditch and tributary stream. The denuded field is shown in Figure 27. This field has since been converted into a hay lot, which acts as a buffer between the barnyard activities and the roadside ditch and tributary stream. The newly vegetated buffer area is depicted in Figure 28.

Vegetative Buffer Strip. Runoff and leachate from the feed bunk were conveyed to the

roadside ditch through drainpipes. During rain events, runoff from the bunk would enter a catchbasin and flow directly to the roadside ditch. In addition, the catchbasin was located near the bunk in a cow barn. As a result, the runoff would carry feed as well as manure solids to the roadside ditch and tributary stream. There were also drain tiles under the feed bunk that would convey ground water and silage leachate to the roadside ditch. During periods of high ground water elevation, these tiles would collect primarily diluted silage leachate; however during dry conditions the silage leachate was very strong. These pipes were removed and redirected to a system consisting of a bark filter, level spreader and vegetative buffer strip area. At the end of the vegetative buffer strip is a standpipe that collects the water and conveys it to the roadside ditch. The purpose of this system is to provide treatment through filtration, deposition, infiltration, absorption, decomposition and volatilization before it enters the roadside ditch and tributary stream. The bark filter, level spreader and vegetative buffer strip area immediately after construction is depicted in Figure 29.

Roof Water Management. The clean water falling on barn roofs represented a major fraction of the original runoff discharged into the roadside ditch. Prior to BMP implementation, the water falling off the roofs traveled over feed bunks, driveways and barnyards. This resulted in greater volumes of polluted water reaching down-gradient areas.

An existing gutter system had lost several brackets and was no longer functioning. The water spilled into the gap between two barns and then ran across a barnyard, carrying manure and other solids. This section was replaced and piped into other clean water diversions.

New gutters and downspouts were installed on several buildings, the largest of which was for the machinery barn. The collected water was piped to a ditch outlet without mixing with other runoff. While the new pipes diverted much of the rainwater, substantial volumes of water were still discharging into the newly constructed bark filter.

In general, agricultural BMP implementation at the Leubner farm did not progress as planned. Some work items were omitted while others were added due to field modifications. The information obtained from members of the Leubner family during design was not entirely accurate and as a result, some field modifications were necessary. The most significant change resulted from inaccurate information relating to the depth of drain tile from the bunk silage area. For example, during design we were informed that the tile drain was two feet deep but in the field it was found to be actually three and one-half feet. Because of this discrepancy, the upper bark filter was moved to the field below the driveway and is now actually the lower bark filter.

One of the early accomplishments at the Leubner farm was to inventory the many drainpipes and identify their origin. Originally all the drainpipes from both clean and contaminated sources were connected to a 10-inch pipe that discharged to the roadside ditch/stream. During the first phase of work drainpipes from the manure handling area and bunk silage area were disconnected

and redirected towards the new bark filters. Currently only the roof water is directly piped to the roadside ditch/stream.

5.2 Urban BMPs

Stormwater Vortex Unit

A stormwater vortex unit was installed at 134 East Seneca Turnpike for the purpose of removing suspended solids and associated nutrients from the stormwater before discharge to Onondaga Creek. The catchment area serviced by this unit primarily encompasses a 1,000-feet length of East Seneca Turnpike and is approximately 1.2 acres in size. The unit is a 4-foot diameter Hydro International Downstream Defender® with a design flow of 0.75 cfs and a maximum capacity of 3.0 cfs. Figure 30 shows a portion of the catchment area and Figure 31 shows the unit during installation.

Installation of the Downstream Defender® was fairly simple, considering that the location of the stormwater sewer was on the edge of a busy city street. As a result of the location of the sewer, the unit was installed off-line instead of directly in-line with the sewer. This required removing a three-foot section of the sewer and replacing it with a diversion manhole. The diversion manhole was constructed with a weir wall that diverts flow out of the stormwater sewer and into the unit. Once the flow is processed through the unit it is piped back into the diversion manhole on the other side of the weir wall where it flows back into the stormwater sewer.

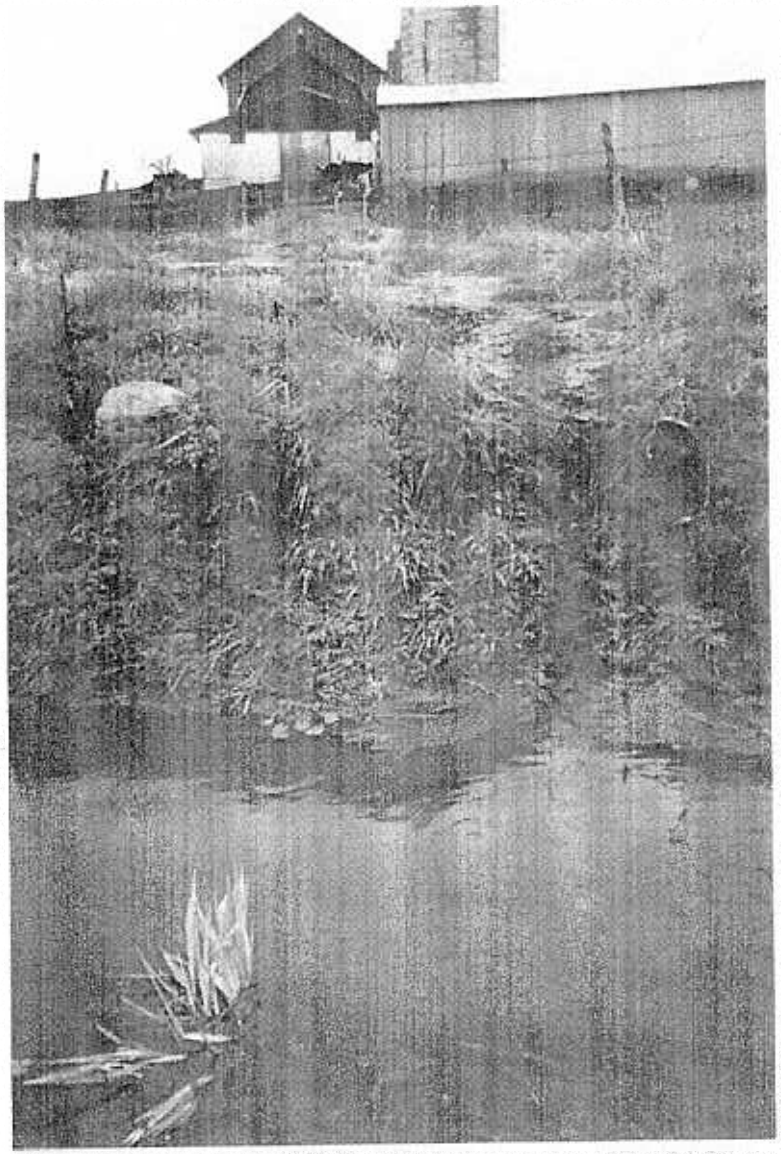
In general, construction of the Downstream Defender® proceeded as planned. However, pre-cast concrete components of both the Downstream Defender® and the diversion manhole were not cast to the specified dimensions. These components were not rejected but modified in the field to meet the specifications.

Vegetative Filter Strip

A stormwater vegetative filter strip was installed at the Onondaga County Burnet Park Zoo for the purpose of controlling and treating runoff from a parking lot. The original stormwater structure for this parking lot was a cobblestone-lined ditch, which was constructed around 1985. This ditch no longer functioned as originally designed. The cobblestone had filled with sediment and a berm had formed at the edge of the parking lot, which prevented runoff from reaching the ditch. The original ditch is illustrated in Figure 32.

The vegetative BMP is a 160-foot long swale, which collects and conveys runoff from the parking lot. The ditch was reshaped to convey flow at rates that minimize erosion. Four to six inches of a compost/topsoil material was placed on the finished grade as a seedbed for

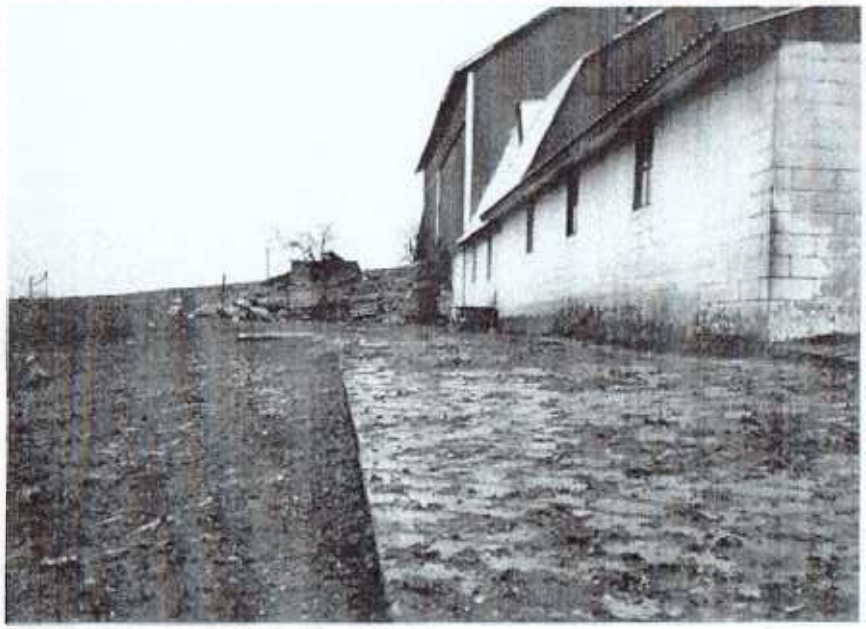
vegetation. The compost was produced from food scrapes, leaves, woodchips and manure generated from around the county, including the Burnet Park Zoo. The area was seeded with a mixture of grasses. These grasses were selected to be resilient against invading species, to grow well in a wet and dry environment and to only grow to approximately two feet tall. These grasses will only be mowed once per year in an attempt to attract meadow type birds to this area. Figures 33 and 34 show the reshaping of the original ditch and the application of the compost, respectively.



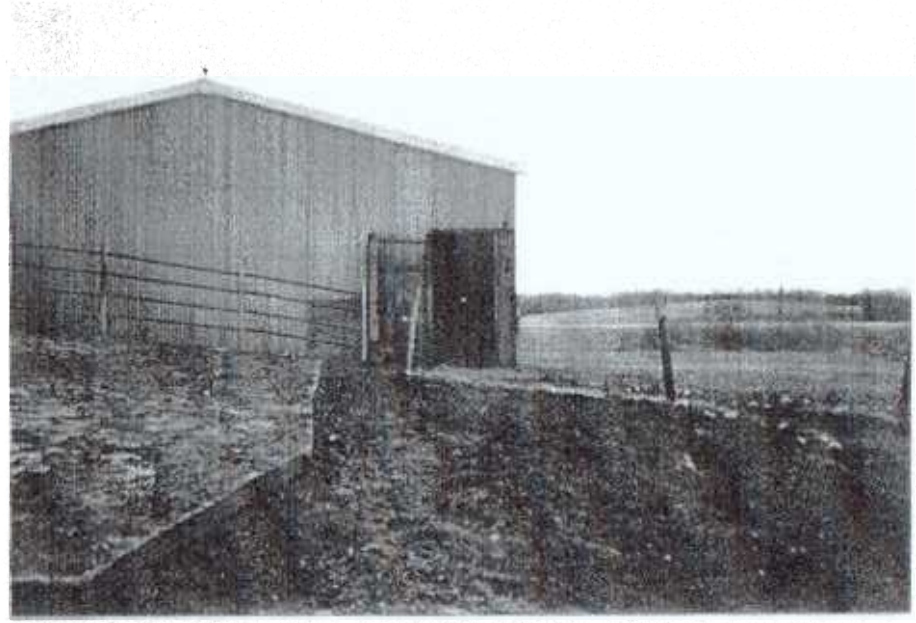
Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Overland Flow

Figure 9



Rohe Farm Pre-BMP Barnyard



Rohe Farm Pre-BMP Barnyard and Denuded Area

Rohe Farm Post-BMP New Concrete Pad with Barkfilter

Rohe Farm Post-BMP Barkfilter and Vegetative Buffer

Moffa & Associates
A unit of Brown and Caldwell

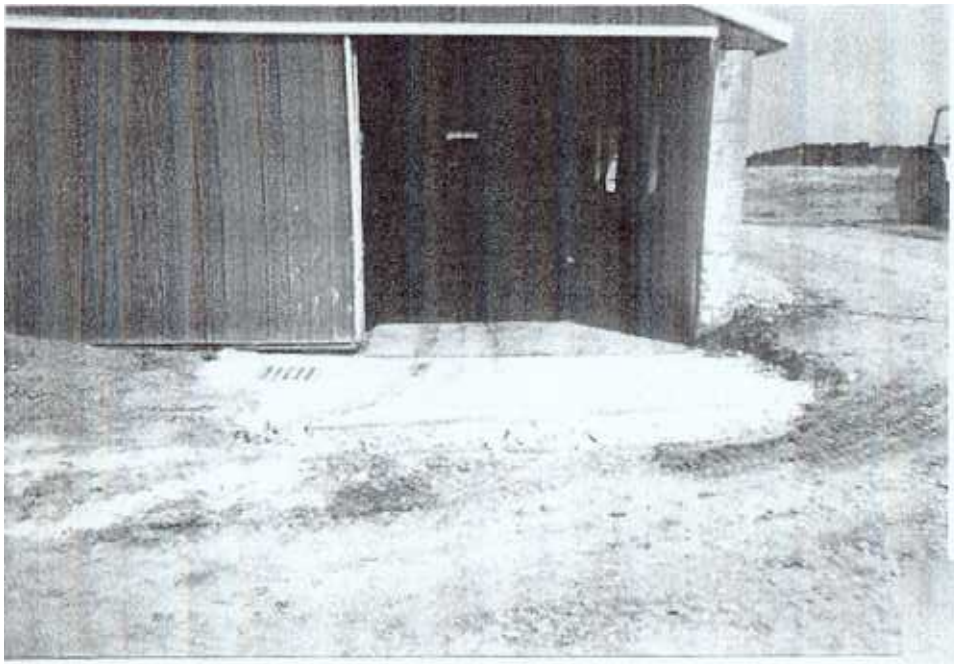
Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP New Concrete Pad with Barkfilter and Vegetative Buffer

Figures 12 & 13

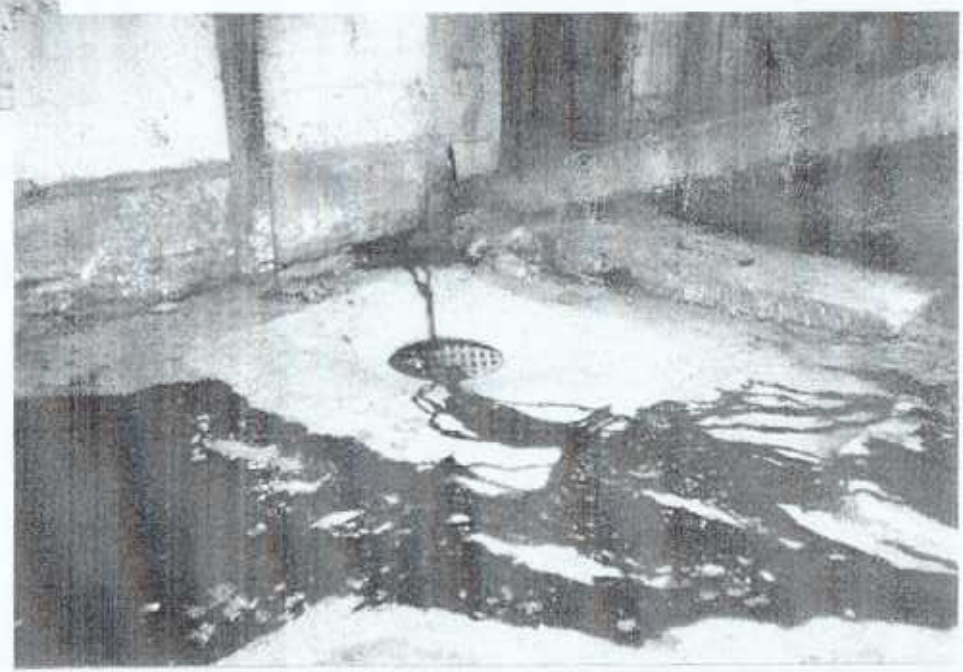
Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Manure Handling Station with Drain to Brook

Figure 14

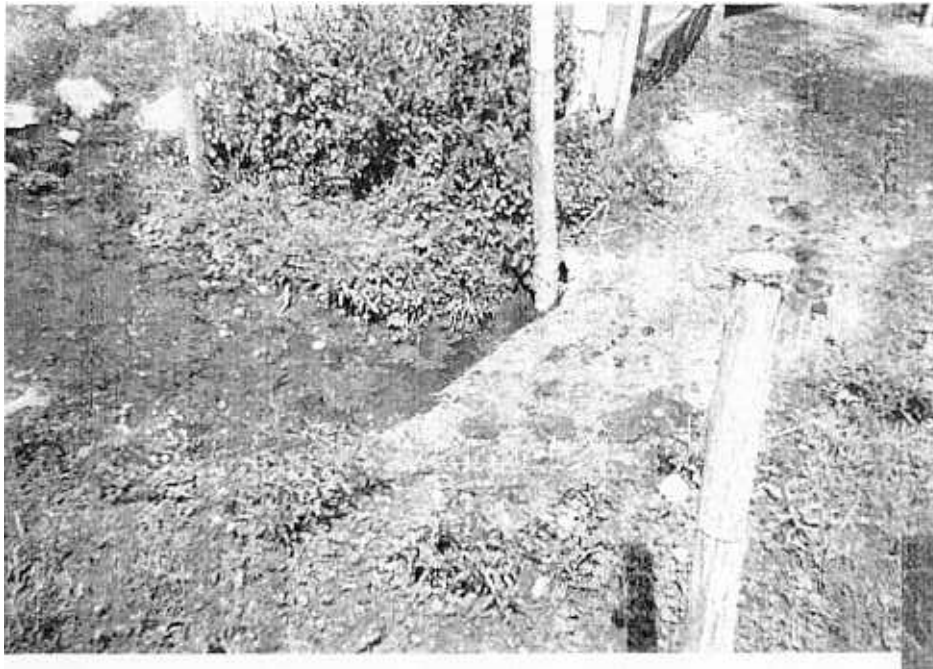


Rohe Farm Post-BMP New Concrete & Catchbasin
to Prevent Run-on



Rohe Farm Post-BMP New Manure Sump Pit

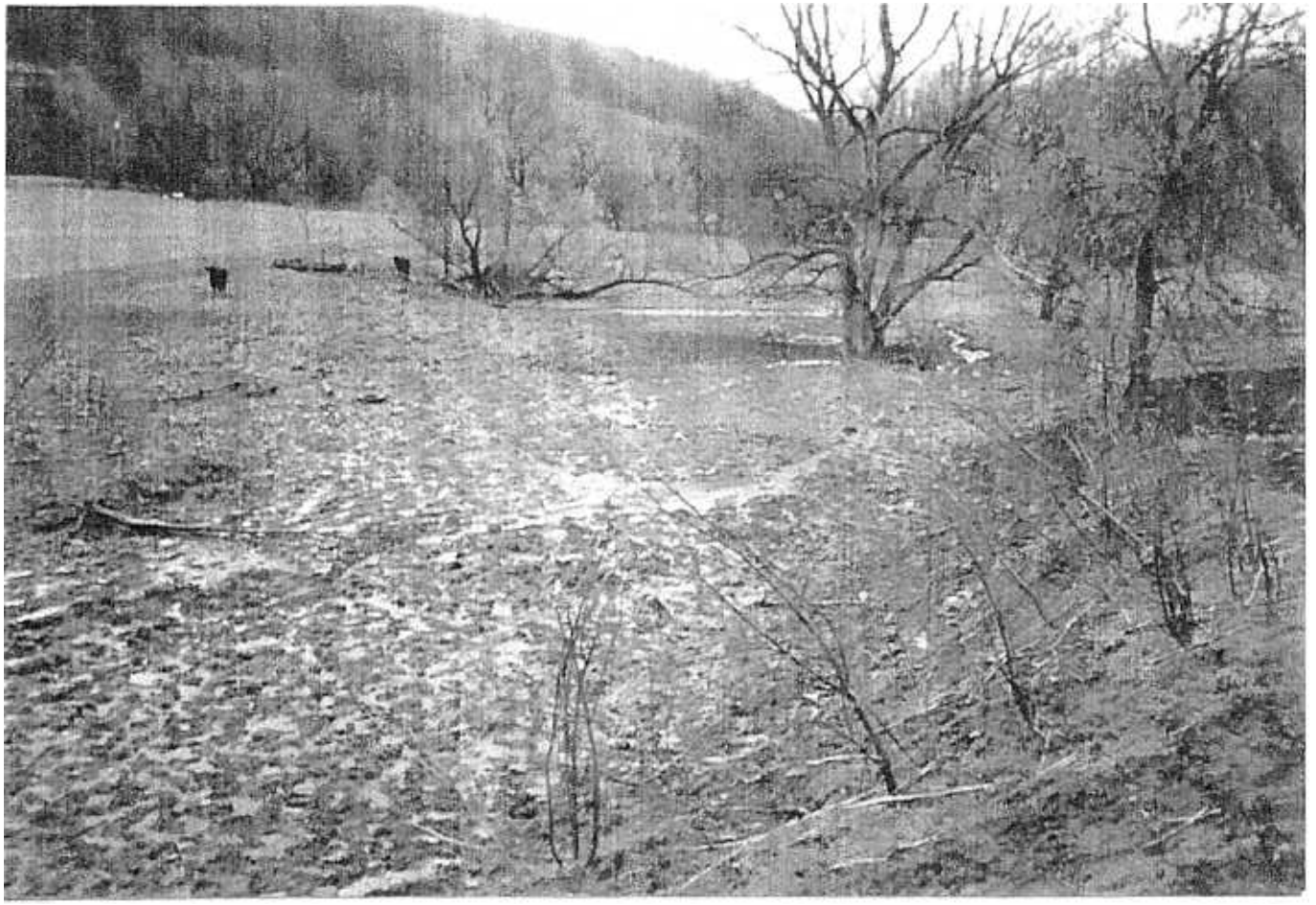
Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Rohe Farm Post-BMP New Concrete & Catchbasin to Prevent Run-on and New Manure Sump Pit**	**Figures 15 & 16**



Rohe Farm Pre-BMP Poor Drainage in Concentrated Animal Area

Rohe Farm Post-BMP Catchbasin & Animal Exclusion Fence

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Rohe Farm Pre-BMP and Post-BMP Drainage Improvement**	**Figures 17 & 18**

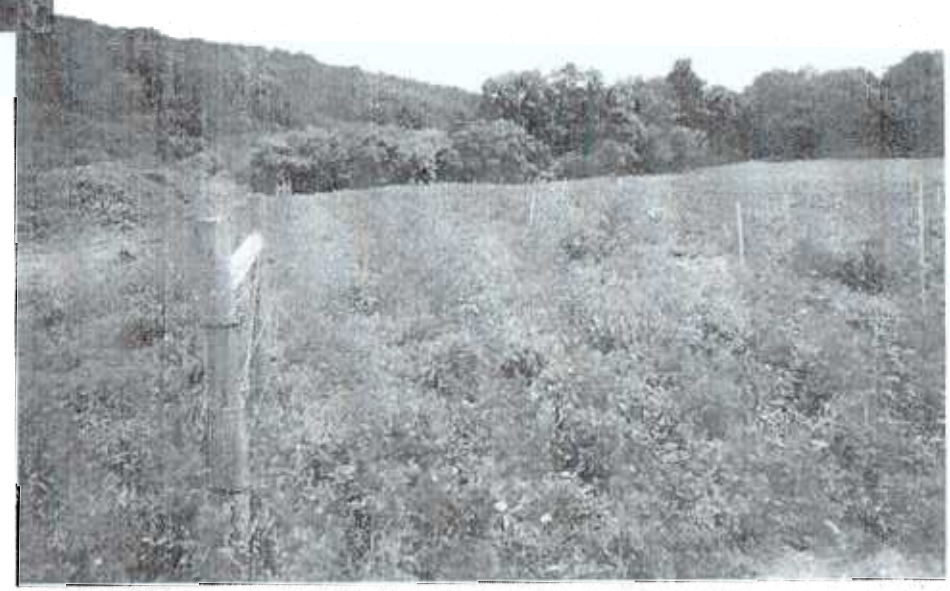


Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Denuded Streambed

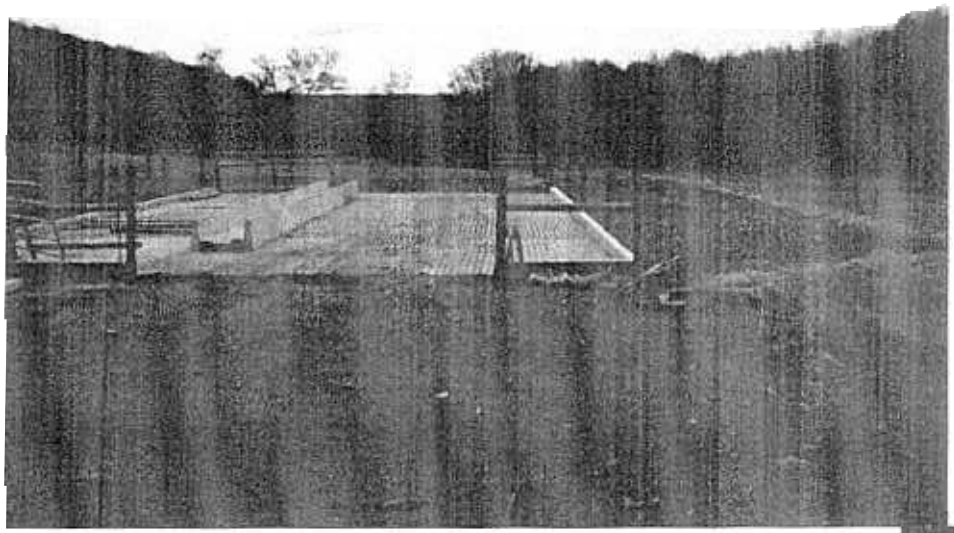
Figure 19

Guptill Farm Post-BMP Re-vegetated Streambed

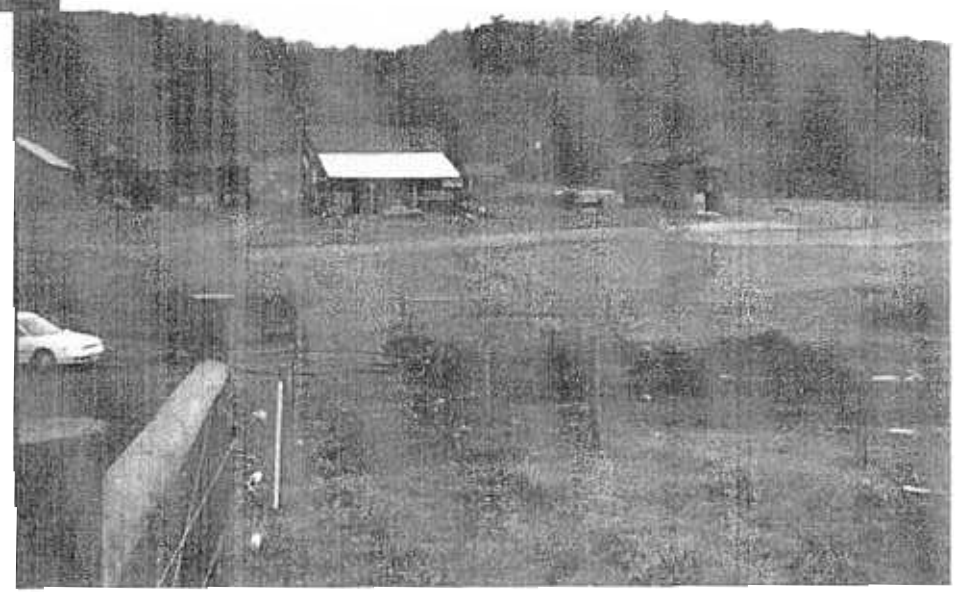


Guptill Farm Post-BMP New Rotation
Grazing Pasture

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Guptill Farm Post-BMP Re-vegetated Streambed and Grazing Pasture**	**Figures 20 & 21**



Guptill Farm Post-BMP New Concrete Pad with Barfilter



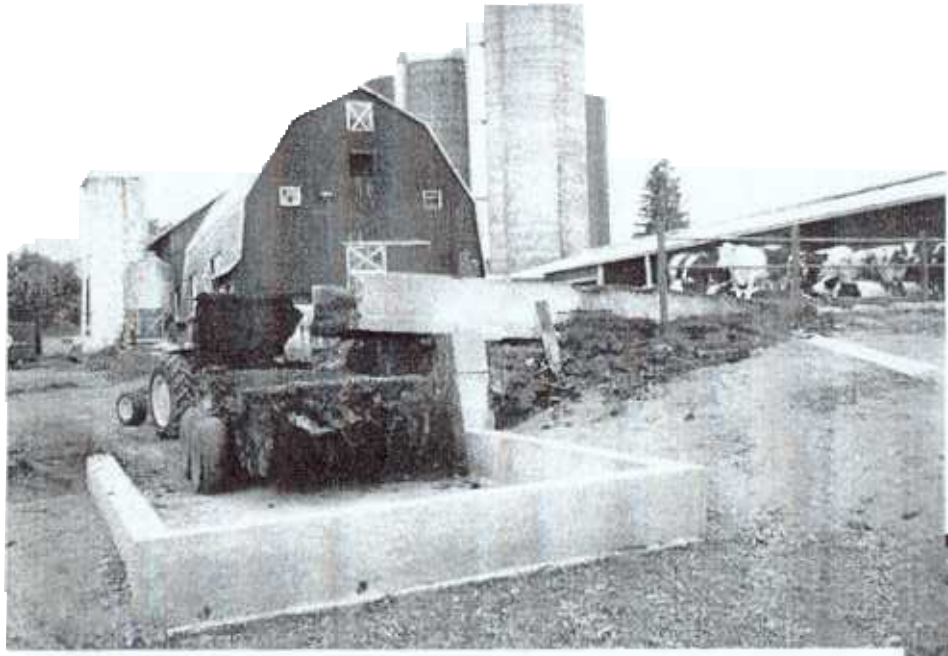
Guptill Farm Post-BMP New Rotation Grazing Pasture & Feed Area

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Guptill Farm Post-BMP New Concrete Pad with Barfilter and New Rotation Grazing Pasture & Feed Area**	**Figures 22 & 23**

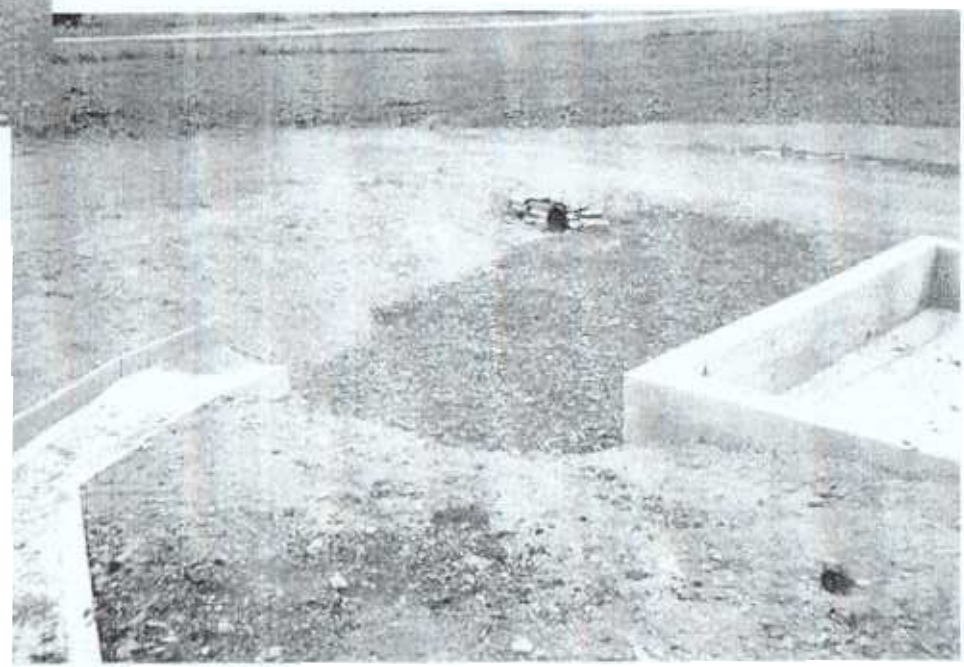
Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre-BMP Manure Handling Station

Figure 24

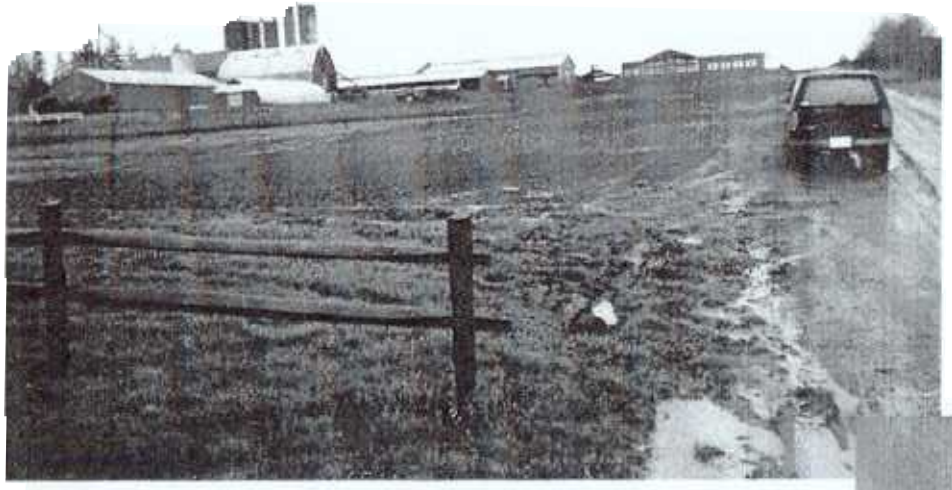


Leubner Farm Post-BMP New Manure Handling Station

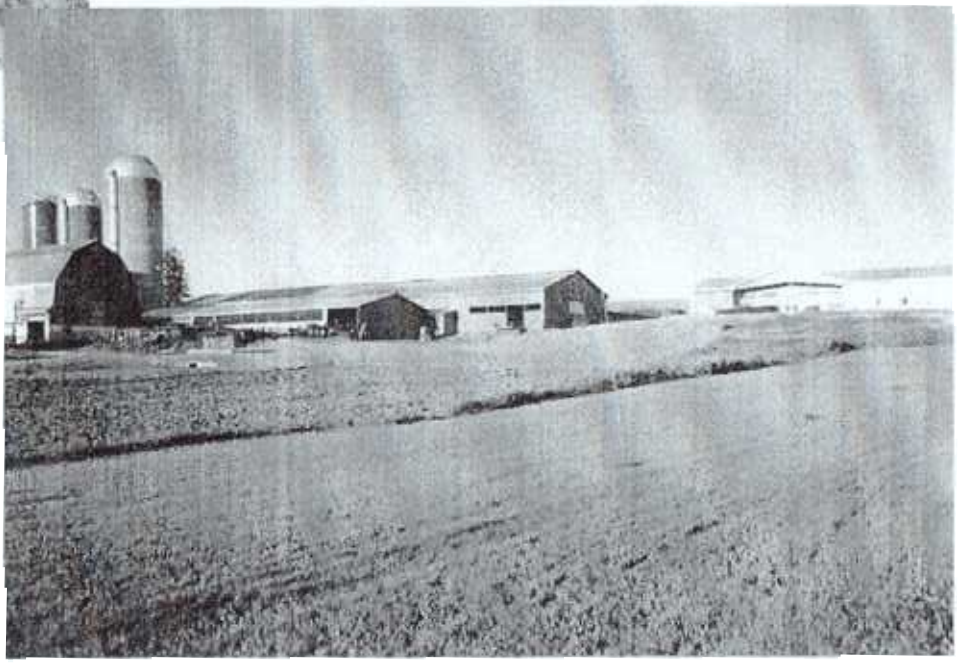


Leubner Farm Post-BMP New Barkfilter for Manure Handling Station

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Leubner Farm Post-BMP New Manure Handling Station with Barkfilter**	**Figures 25 & 26**

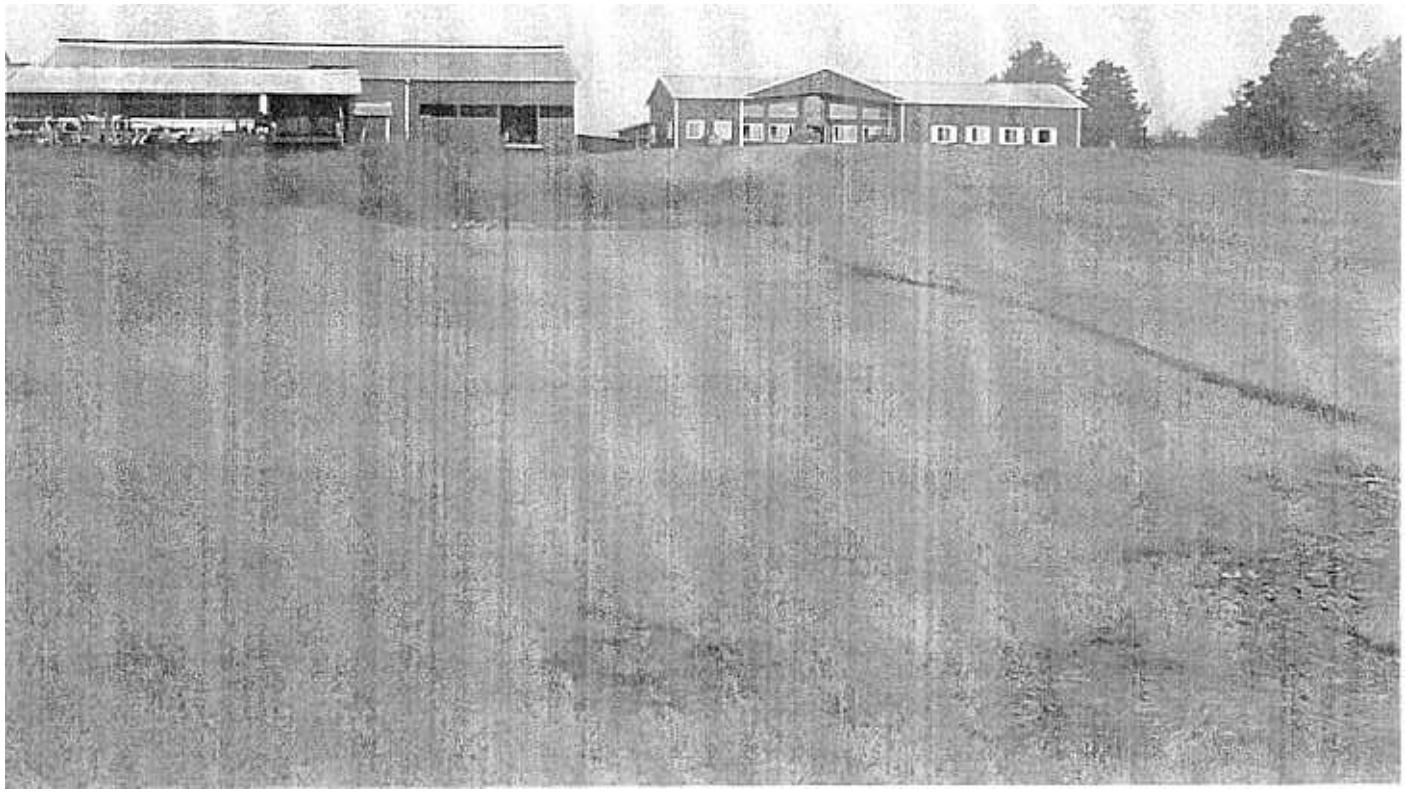


Leubner Farm Pre-BMP Denuded Pasture Field



Leubner Farm Post-BMP New Vegetative Buffer Area

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Leubner Farm Pre-BMP Denuded Pasture Field and Post-BMP New Vegetative Buffer Area**	**Figures 27 & 28**



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Post-BMP New Barkfilter and Vegetative Strip

Figure 29

Stormwater Vortex Unit Catchment Area

Stormwater Vortex Unit Installation

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A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Stormwater Vortex Unit Catchment Area and Unit Installation

Figures 30 & 31

Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Vegetative Buffer Strip Pre-BMP

Figure 32

Vegetative Buffer Strip Post-BMP Reshaping Ditch

Vegetative Buffer Strip Post-BMP Compost Application

Moffa & Associates A unit of Brown and Caldwell	**Onondaga Lake Watershed, Nonpoint Source EBP** **Vegetative Buffer Strip Post-BMP Reshaping Ditch and Compost Application**	**Figures 33 and 34**

6 ROUTINE AND WET-WEATHER/HIGH FLOW WATER QUALITY MONITORING

The EBP water quality sampling program provided data that were intended to provide only a first order approximation of farmstead and urban runoff pollutant concentrations and effectiveness of BMPs. Prior to this sampling program there were no site-specific data for urban and farmstead runoff available for the City of Syracuse and surrounding agricultural land. The results from this first order approximation should be considered accurate within 50%. For example, it was estimated that 865 lbs of total phosphorus discharged from the Rohe farm before BMP implementation. Based on this approach, the total phosphorus load was likely greater than 430 lbs but less than 1700 lbs. The sampling approach was consistent with budgetary constraints, which allocated 85% of the budget for BMP implementation and the remaining 15% for sampling and monitoring, laboratory analyses, data analyses, meetings and reporting.

If not otherwise noted the water quality analyses included the following parameters:

Parameter	Method
1 Soluble Reactive Phosphorus (Ortho-Phosphorus)	
2. Total Phosphorus (Total-P)	
3 Total Kjeldahl Nitrogen (TKN)	351.3
4. Total Suspended Solids	160.3

Notes:

USEPA Methods for Chemical Analysis of Water and Waste 1979

6.1 Agricultural BMPs

Water quality samples were taken downstream from the farmsteads once per month for one year before and after BMP implementation. Instantaneous flow measurements were taken at the same time as the water quality data.

The intent of the sampling and monitoring program was to measure the effects of BMPs; therefore, it was originally proposed to sample water quality downstream of the BMPs only. However, during the course of the project questions evolved regarding the amount of solids and nutrients originating upstream of the farmsteads (i.e., upstream of the BMPs). In order to establish solids and nutrients levels upstream of the farms, water quality samples were taken

from upstream locations. A full matching set of upstream samples were not taken due to budgetary constraints. However, the data collected from the upstream sampling locations were used to estimate the solids and nutrient loads originating upstream of the farmsteads and from the farmsteads. Though this data was limited, its intent was to give an indication of the magnitude of change in water quality as the receiving waters flow passed the farmsteads.

Agricultural pre-BMP water quality data were collected during the period July 1999 to June 2000. Pre-BMP runoff from the agricultural sites was representative of moderate to strong wastewater, in terms of solids, phosphorus and nitrogen. Table 6 presents the pre-BMP water quality data from the three farms.

Agricultural post-BMP water quality sampling began in November 2000 and continued until November of 2001. Water quality samples were taken at the same location as the pre-BMP samples. These data are presented in Table 7.

Rohe Farm

Water quality samples for the Rohe Farm were taken in an intermittent stream (headwaters of Harbor Brook) approximately 100 feet west of the main barn and barnyard area. Runoff from the farmstead originally reached the intermittent stream primarily through overland flow and tile drains. The discharge from the overland flow and tile drains represented runoff and/or groundwater from the barn, milkhouse, manure handling station and barnyard and pasture areas. Upstream samples were taken in the same reach of stream, approximately 200 feet above the active farmstead area. These sampling locations are illustrated in Figure 35.

The Rohe farm sampling location provided the greatest potential for solids and associated nutrients to settle in the creek during periods of very low flow. These solids had the potential to accumulate during dry periods and flush from the creek bottom during larger storms and spring runoff. In terms of water quality sampling, the largest load of nutrients is likely discharging from the farm in the summer, but stays resident in the creek until the spring runoff period. This would have the effect of increasing the spring runoff nutrient load. In addition, it would affect the pre-BMP sampling data more since more solids were observed discharging from the farm before BMP implementation. It is likely that this flushing phenomena is occurring throughout the watershed.

Guptill Farm

Water quality samples for the Guptill Farm were taken from overland flow within the original pasture area, approximately two-thirds the distance from the beginning of the pasture area. This flow originates on the farm and is the headwaters to a tributary of the West Branch of Onondaga

Creek. In the case of the Guptill farm, the farmstead was truly at the headwaters of the creek. In the absence of an appropriate upstream sampling location, samples were not taken. The upstream sampling location is illustrated in Figure 36.

Leubner Farm

Water quality samples for the Leubner Farm were taken from a roadside ditch approximately 400 feet east of the manure handling station. Runoff from the farmstead reached the roadside ditch primarily through tile drains. The discharge from the tile drains represented runoff and/or groundwater from the bulk silage area, the barn and manure handling station and barnyard and pasture areas. These direct discharges no longer exist. Upstream samples were taken in the same ditch, approximately 300 feet above the active farmstead area. These sampling locations are illustrated in Figure 37.

6.2 Urban BMPs

The water quality sampling efforts for the two urban BMPs were performed during the summer and fall of 2001 and spring of 2002. The influent and effluent of each of these urban BMPs was sampled simultaneously. Water quality for each BMP was sampled during at least six rain events.

Stormwater Vortex Unit

During a sampling event, stormwater was sampled from the influent and effluent of the Downstream Defender® at the locations illustrated in Figure 38. During the first five events, these samples were taken with a US DH-81A sampler, which was specifically designed for sampling sediment in flowing water. A photo of the US DH-81A sampler is illustrated in Figure 39. Because there was some concern that the US DH-81A sampler was not taking representative samples of the sediment load, a Van Dorn sampler was used to sample during the last event. The Van Dorn sampler is illustrated in Figure 40. Grab samples from each location were taken at approximately 15-minute intervals throughout a rain event and attempts were made to collect the first flush of stormwater from each rain event. For each pair of influent and effluent samples, the influent sample was taken first and the effluent sample was taken second with approximately 1-2 minutes between the samples.

During the first four events, each influent and effluent grab sample was analyzed for TSS, phosphorus and nitrogen. During the last two events, only TSS was analyzed because there was no clear indication of nutrient removal, and the data from the first four events provided adequate information regarding nutrient runoff in this urban stormwater. Furthermore, during the last two events the laboratory procedures for TSS were changed to reflect the industry's new

understanding of laboratory bias (USGS, 2000) with respect to heavy solids and the TSS analysis. In general, the original TSS analysis allowed the laboratory to spilt the primary sample for the purpose of performing the analysis with a single filter of size 24 or 42 mm. Research has shown that splitting stormwater samples that contain solids larger than 62 micron can bias the TSS results downward by as much 50% (USGS, 2000). The new TSS method (also known as ASTM 3977 Suspended Sediment Concentration) required the laboratory to filter the entire sample and not take a split or sub-sample.

The changes made to the sampling method and solids analysis appeared to increase the concentration of solids measured. It is likely that the data collected from the first five events were biased low due to the type of sampler used and the analysis method. Further more the influent samples were likely biased more than the effluent samples because of the higher percentage of coarse grit in the influent. Based on field observations, the effects of changing the sampling method were greater than the effects of changing the solids analysis. Due to time and budget constraints, comparative sampling was not completed. As a result influent versus effluent comparisons were made only for the sixth event when both the Van Doran sampler was used and the ASTM 3977 solids analysis were used.

Flow was measured continuously in the effluent pipe of the Downstream Defender® using a Marsh McBirney depth/velocity flow meter and data logger, Model 260C. Rain was measured continuously with a tipping rain bucket with data logger. The rain gauge was installed on the roof of St. James School approximately 200 feet from the Downstream Defender®.

6.2.2 Vegetative Filter Strip

During a sampling event, influent stormwater was sampled from the edge of the parking lot as it flowed onto the vegetation and the effluent sample was taken at the end of the vegetative strip as depicted in Figure 41. Grab samples were taken manually from each location at approximately 15-minute intervals throughout a rain event and attempts were made to collect the first flush of stormwater from each rain event. These samples were composited into one influent and one effluent sample per event and analyzed for TSS, phosphorus and nitrogen.

Month	Date	Rohe Farm Flow gpm	Rohe Farm TSS mg/l	Rohe Farm TKN mg/l	Rohe Farm Total P mg/l	Rohe Farm Ortho P mg/l	Rohe Farm (Upstream) Flow gpm	Rohe Farm (Upstream) TSS mg/l	Rohe Farm (Upstream) TKN mg/l	Rohe Farm (Upstream) Total P mg/l	Rohe Farm (Upstream) Ortho P mg/l	Guptill Farm Flow gpm	Guptill Farm TSS mg/l	Guptill Farm TKN mg/l	Guptill Farm Total P mg/l	Guptill Farm Ortho P mg/l
May	5/13/1999	0	450	4.24	0.89	0.68						0	980	2.85	0.86	0.06
June	6/25/1999	2	1730	166	67	41.2						25	51	31	6.02	2.34
July	7/31/1999	5	325	11.2	26.5	23.4						0	1400	42.6	14.6	3.25
Aug	8/13/1999	2	870	10.1	1.51	NA						0	3700	356	54.4	NA
Sept	9/16/1999	5	2350	40.6	10.3	5.25	0	40	0.81	0.82	0.03	60	830	47.9	6.65	3.23
Sept	9/22/1999	2	1190	101	19.6	12.2						5	530	20.2	5.84	2.45
Feb	2/25/2000	400	18	7.17	1.74	1.49	400	14	2.04	0.23	0.09	180	76	17.2	3.39	1.93
March	3/15/2000	600	7	2.97	0.16	0.05	600	7	0.5	0.03	0.02	180	68	1.85	0.32	0.06
March	3/28/2000	1500	66	2.98	0.51	0.26	1500	4.5	0.57	0.02	<0.02	180	533	34.1	3.35	0.6
April	4/18/2000	600	33	2.85	0.42	0.1	600	12	<.05	<0.02	<0.02	150	172	7.21	1.15	0.25
May	5/18/2000	325	26	1.27	0.19	0.11						700	1250	13.3	3.68	0.44

Not Routinely Sampled

Month	Date	Leubner Farm Flow gpm	Leubner Farm TSS mg/l	Leubner Farm TKN mg/l	Leubner Farm Total P mg/l	Leubner Farm Ortho P mg/l	Leubner Farm (upstream) Flow gpm	Leubner Farm (upstream) TSS mg/l	Leubner Farm (upstream) TKN mg/l	Leubner Farm (upstream) Total P mg/l	Leubner Farm (upstream) Ortho P mg/l
May	5/13/1999	0	8280	508	68.1	38.4					
June	6/25/1999	50	180	156	22	10.2					
July	7/31/1999	84	260	61.1	15.3	8.22					
Aug	8/13/1999	10	2120	330	59.6	NA					
Sept	9/16/1999	200	390	33.3	13.7	6.27					
Sept	9/22/1999	20	85	26.5	7.15	4.15	2	34	0.5	0.38	0.3
Feb	2/25/2000	300	47	10.6	2.02	1.45	200	24	0.5	1.34	0.09
March	3/15/2000	100	71	29.7	3.84	1.71	70	34	0.5	0.07	0.02
March	3/28/2000	100	63	17.2	2.92	1.91	70	13	0.6	0.17	0.12
April	4/18/2000	60	124	15.8	3.18	1.57	10	16	<.5	0.07	0.04
May	5/18/2000	250	555	16.2	3.81	1.16					

Not Routinely Sampled

Notes Regarding Missing Data:

1. In the case of the Guptill farm, the farmstead was at the headwaters of the creek. In the absence of an appropriate upstream sampling location, samples were not taken.
2. The intent of the sampling program was to measure the effects of BMPs by collecting water quality samples downstream of the BMPs only. Upstream sampling was not requested until September 1999. Therefore no upstream samples were taken before this time. However, during the course of the project questions evolved regarding the amount of solids and nutrients originating upstream of the farmsteads (i.e., upstream of the BMPs). Upstream sampling did not occur every month due to budgetary constraints.
3. On 9/16/1999 orthophosphate was analyzed for due to laboratory error.
4. Flow values of 0 gpm represent times when the actual flow was too slow to measure.

Month	Date	Rohe Farm Flow gpm	Rohe Farm TSS mg/l	Rohe Farm TKN mg/l	Rohe Farm Total P mg/l	Rohe Farm Ortho P mg/l
November	11/15/2000	600	8.0	0.69	0.04	< 0.02
January	1/30/2001	600	8.0	1.15	0.23	0.16
March	3/13/2001	600	71.0	6.42	0.79	0.54
March	3/30/2001	1350	40.0	2.53	0.88	0.56
April	4/12/2001	375	6.0	0.65	0.18	0.02
May	5/23/2001	93.5	35.0	4.51	1.41	0.76
June	6/21/2001	100	89	3.61	0.41	0.18
August	8/28/2001	No flow				
September	10/6/2001	10	52.0	4.33	1.43	0.15
October	10/25/2001	20	14	1.09	0.44	0.03
November	11/7/2001	20	30	2.75	1.01	0.09

Rohe Farm (Upstream) Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l
600	1.0	< 0.5	< 0.02	< 0.02
Not Sampled				

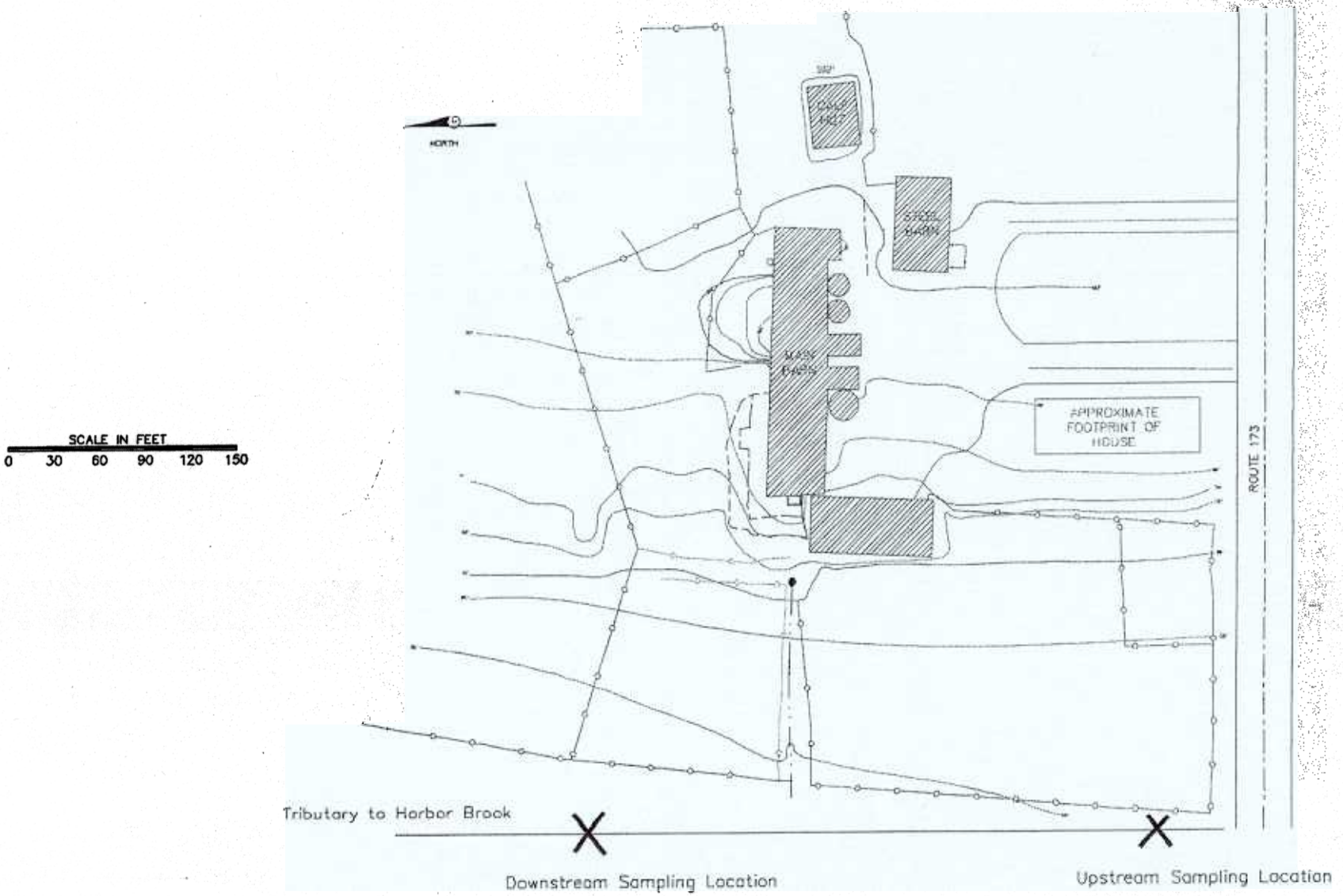
Guptill Farm Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l
100	10	0.98	0.09	0.02
250	393	6.11	2.47	0.91
450	1180	15.6	4.18	0.74
600	897.0	10.8	2.92	0.64
225	10.0	0.5	0.06	0.03
85	87	1.13	0.39	0.13
30	83	6.18	2.57	0.25
0	264	5.34	1.89	1
30	368	3.91	1.65	0.02
60	1176	2.22	2.06	0.35
60	720	3.1	1.82	0.11

Month	Date	Leubner Farm Flow gpm	Leubner Farm TSS mg/l	Leubner Farm TKN mg/l	Leubner Farm Total P mg/l	Leubner Farm Ortho P mg/l
November	11/15/2000					
January	1/30/2001	Not Sampled				
March	3/13/2001					
March	3/30/2001	85	433.0	16.6	3.71	1.1
April	4/12/2001	140	52.0	16.7	1.98	0.84
May	5/23/2001	95	55	11.5	1.88	1.22
June	6/21/2001	20	67.5	23.4	2.38	1.3
August	8/28/2001	10	154	9.95	3	1.84
September	10/6/2001	5	28	10.8	2.8	1.57
October	10/25/2001	10	213	162	12.2	3.89
November	11/7/2001	10	112	60	5.6	3.1

Leubner Farm (upstream) Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l
Not Sampled				

Notes Regarding Missing Data:

1. **In the case of the Guptill farm, the farmstead was at the headwaters of the creek. In the absence of an appropriate upstream sampling location, samples were not taken.**
2. **The intent of the sampling program was to measure the effects of BMPs by collecting water quality samples downstream of the BMPs only. Upstream sampling was not requested until September 1999. Therefore no upstream samples were taken before this time. However, during the course of the project questions evolved regarding the amount of solids and nutrients originating upstream of the farmsteads (i.e., upstream of the BMPs). Upstream sampling did not occur every month due to budgetary constraints.**
3. **On 8/28/2001 samples were not taken at Rohe farm because there was no evidence of flowing water. Some standing water observed, but no sample was taken.**
4. **On 11/15/2000 samples were not taken at the Leubner farm because BMPs were not complete. On 1/30/2001 and 3/13/2001 samples were not taken at the Leubner farm because of significant snow pack covering sampling location.**



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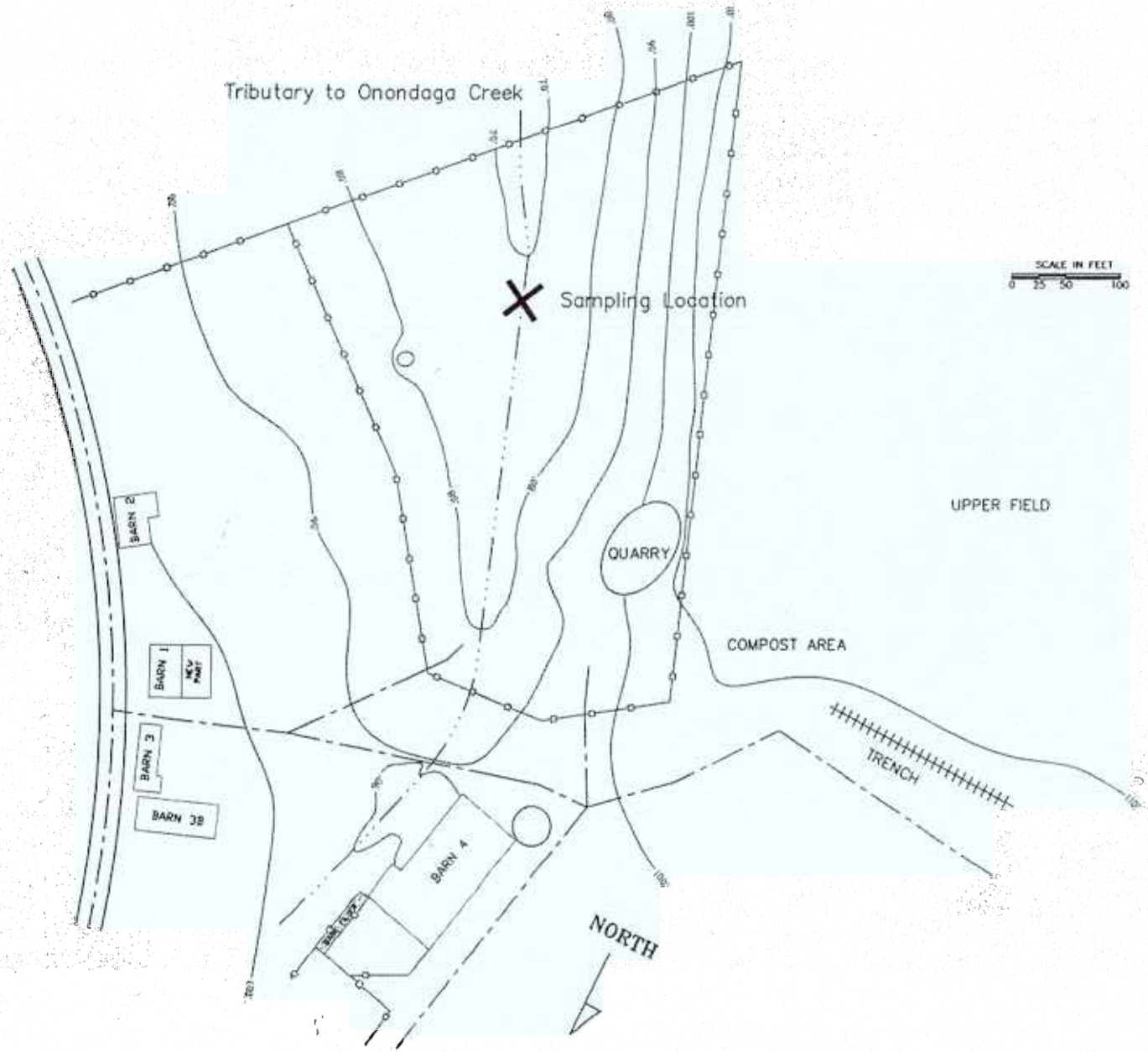
Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Site Layout with Sampling Locations

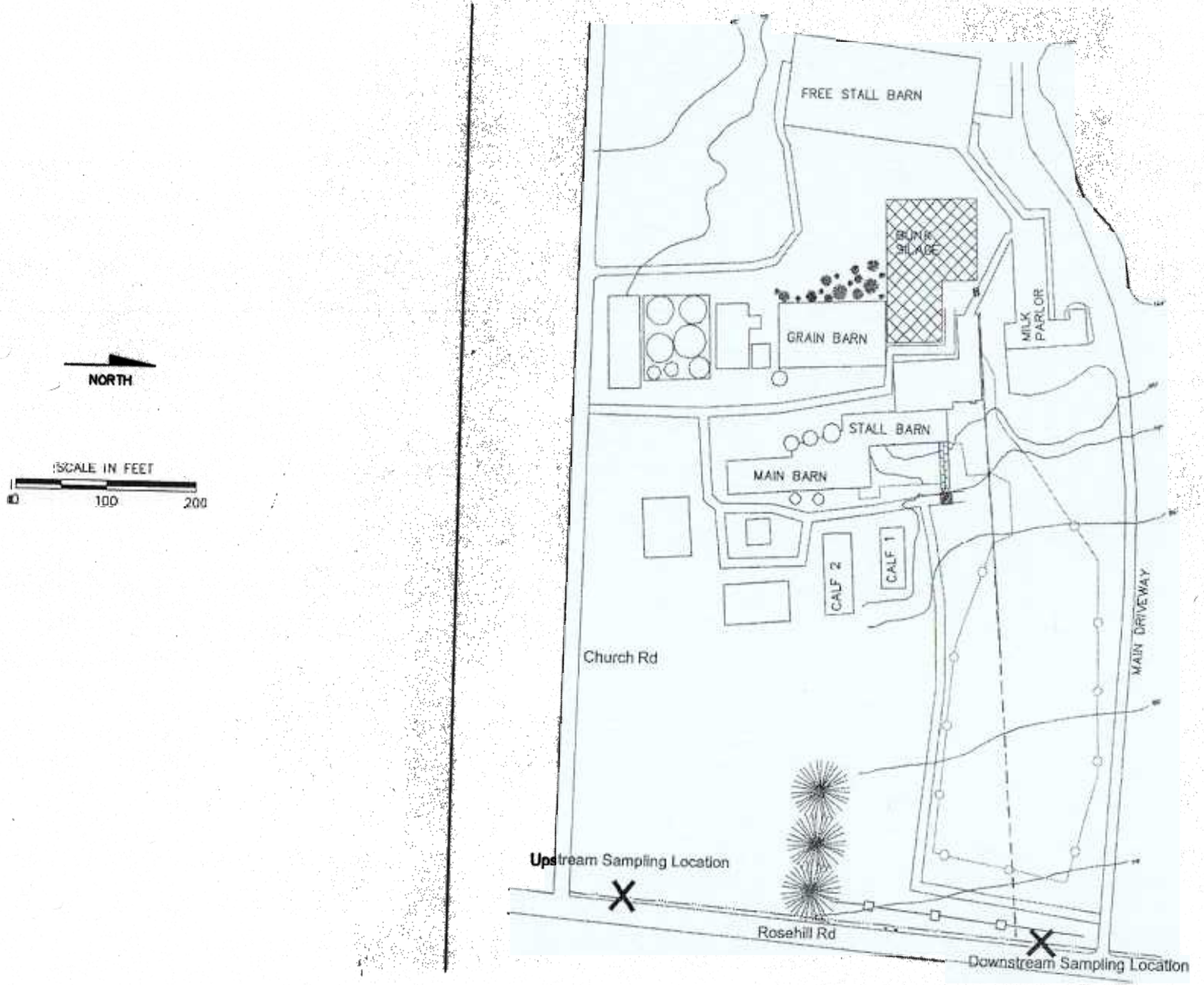
Figure 35



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Site Layout with Sampling Location

Figure 36



Moffa & Associates
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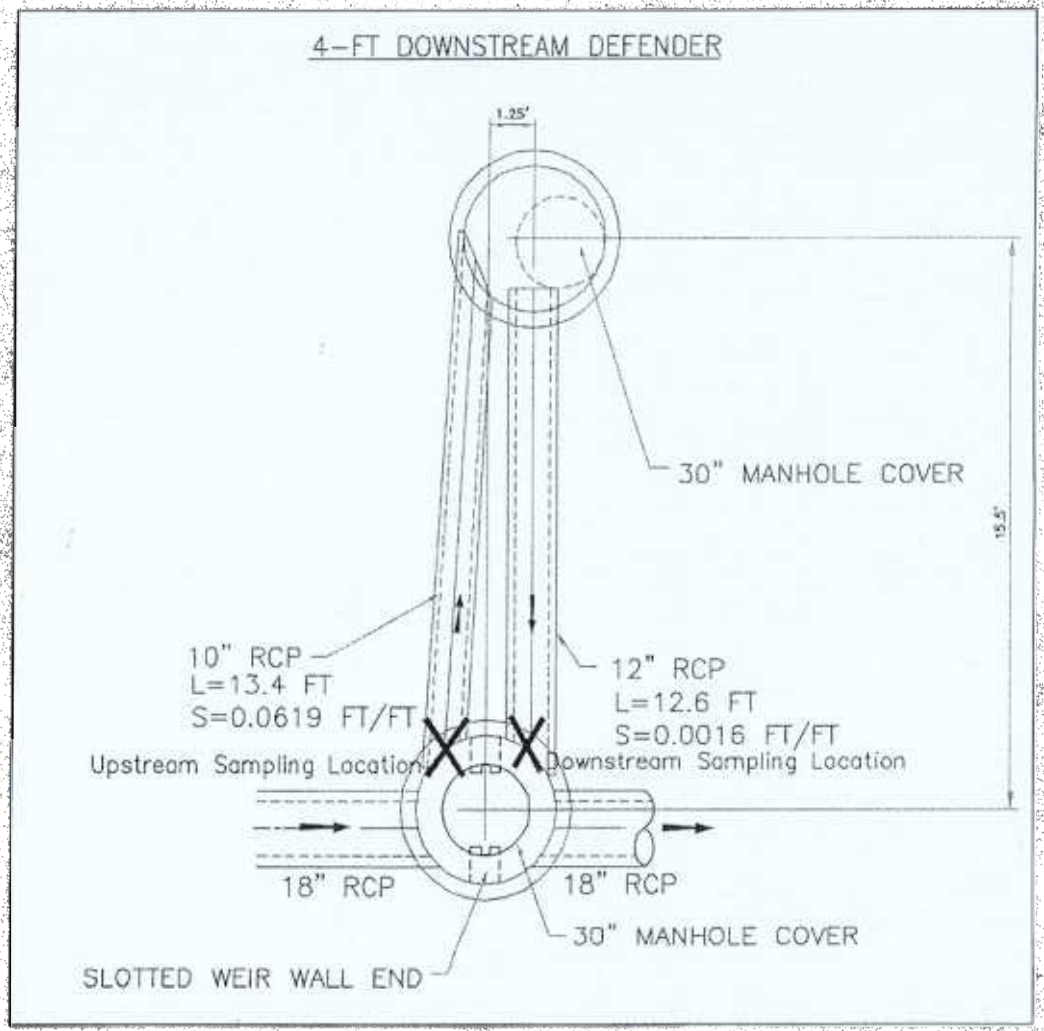
Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Site Layout with Sampling Locations

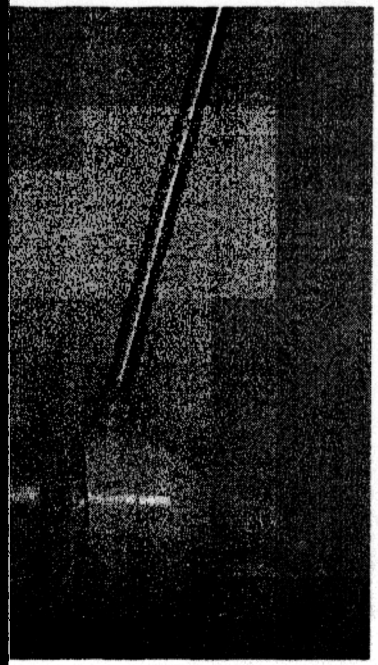
Figure 37

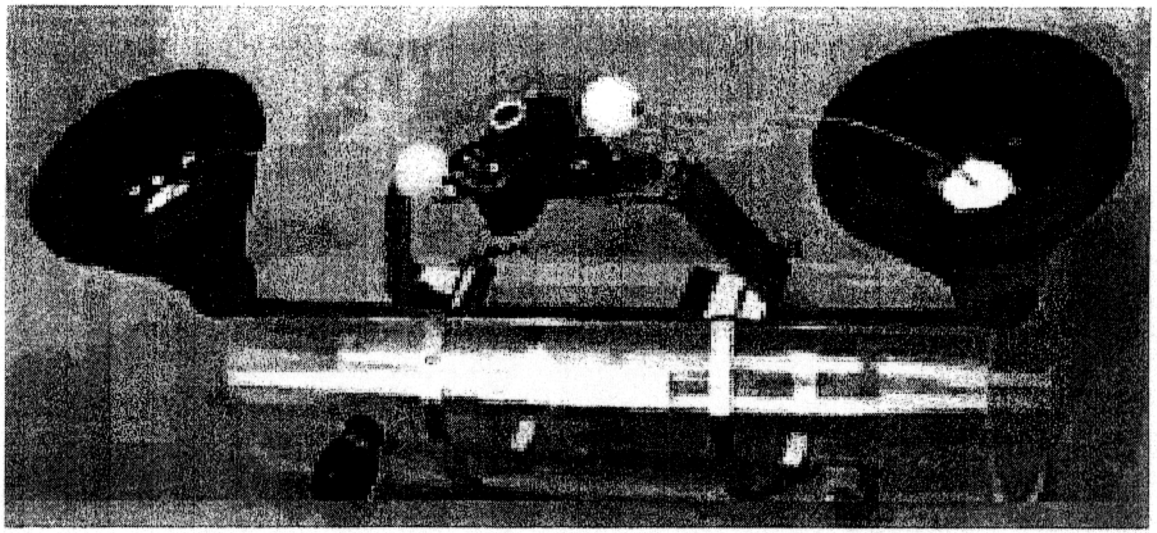


Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Downstream Defender Layout with Sampling Locations

Figure 38





Van Dorn Sampler

S	**Onondaga Lake Watershed, Nonpoint Source EBP** **US DH-81A Sampler and Van Dorn Sampler**	**Figures 39 & 40**

7 DATA ANALYSIS

As stated earlier, data from the EBP sampling are intended to provide only a first order approximation of farmstead and urban runoff concentrations and benefits of BMPs; prior to this sampling program, there were no site-specific data available for urban and farmstead runoff available for the City of Syracuse and surrounding agricultural land.

7.1 Agricultural BMPs

Water quality samples were taken downstream from the farmsteads once per month for one year before and after BMP implementation. Instantaneous flow measurements were taken at the same time as the water quality samples. Water quality samples and instantaneous flow measurements were taken upstream of the farmsteads for the purpose of better understanding background pollution concentrations. For the purpose of this project only the downstream data were used to evaluate the effectiveness of the BMPs.

7.1.1 Estimation of Runoff Hydrographs

Runoff hydrographs were estimated from each farmstead using flow data obtained from the USGS (internet site: http://www.usgs.gov) for Onondaga Creek, Harbor Brook and Nine Mile Creek. The USGS flow data from the nearest gauging station to the farmstead was used, and in each case the gauging station was located downstream from the sampling location. The USGS flow data (average daily flow) were proportioned to represent the drainage area contributing to the sampling location as compared to the drainage area contributing to the gauging station. This proportioning of the flow from the USGS gauging station assumes that the gauging station drainage area evenly contributes flow over its entire area. For instance, the Rohe farm drainage area is estimated as 0.39 square miles and the gauging station drainage area is 10 square miles (USGS Gauging Station 04240100). Therefore, the Rohe farm drainage area is approximately 3.9% of the gauging station drainage area. The estimated runoff hydrograph at the Rohe farm sampling location was therefore calculated by proportioning the total flow measured at the USGS gauging station by 3.9%.

The following is an overview for each farm as it compares to the watershed area of the nearest downstream USGS gauging station.

Rohe Farm:

Stream:	Harbor Brook
USGS Gauging Station:	04240100
Gauge Drainage Area:	10 square miles
Farm Drainage Area:	0.39 square miles

Guptill Farm:

Stream:	Onondaga Creek
USGS Gauging Station:	04239000
Gauge Drainage Area:	88.5 square miles
Farm Drainage Area:	0.60 square miles

Leubner Farm:

Stream:	Nine Mile Creek
USGS Gauging Station:	04240300
Gauge Drainage Area:	115 square miles
Farm Drainage Area:	0.02 square miles

The instantaneous flow measurements made in the field as presented in Tables 6 and 7, were used to calibrate the estimated hydrographs. General trends in the estimated flows were modified to better represent field conditions. For example, the estimated data suggested flow occurred year round at the Rohe farm. However, field data and observations suggest very low flow and frequently no flow during the summer months. As a result, the estimated flows were further calibrated to account for site-specific trends and characteristics.

In general the estimated hydrographs were adjusted downward during the summer and fall seasons and adjusted upwards during the spring runoff period. This is consistent with the watershed characteristics and basic hydrological concepts. The USGS gauging stations are

located upstream of the City of Syracuse but downstream of suburban areas, whereas the farmsteads are located in the very upward reaches of the watersheds. Rains at the farmsteads during the summer and fall seasons are more readily absorbed into the ground than in the lower watershed where there is more impervious area. Therefore higher flows and more extreme flow peaks are expected at the station than at the farmstead. Conversely, snow pack during the winter months tends to be greater in the upper reaches of the watershed than the lower watershed. Therefore relatively high flows during the spring-melt season are expected at the farmstead.

The estimated runoff hydrographs and the instantaneous field measurements for the monitoring period for each of the farms are presented in Figures 42 through 47. Figures 42 and 43 are Rohe pre-BMP and post-BMP years, respectively. Figures 44 and 45 are Guptill pre-BMP and post-BMP years, respectively. Figures 46 and 47 are Leubner pre-BMP and post-BMP years, respectively. The estimated runoff hydrographs are again presented in Figures 60 through 83. These hydrographs along with average seasonal pollutant concentrations (Section 7.1.2) were used to calculate pollutant mass loading the watershed.

7.1.2 Estimation of Average Nutrient Concentrations

Based on the pre-BMP and post-BMP raw data (Tables 6 and 7) it is apparent that there are three distinct flow scenarios that occur during the year: namely, the spring runoff period and the summer and fall runoff periods. In general the spring runoff period is characterized by higher sustained flows and lower nutrient concentrations, whereas the summer and fall runoff periods are characterized by predominately lower flows with some short periods of high flows and higher nutrient concentrations.

Hydrologic responses are a function of physical watershed characteristics, precipitation characteristics and weather conditions. As a result each hydrologic year is unique. Based on this understanding it was not appropriate to simply compare the month of May in the pre-BMP period to the month of May in the post-BMP period. Therefore, average seasonal nutrient concentrations were developed.

The timing and duration of the seasonal nutrient concentrations were not based on calendar days but rather on hydrologic data. For example, May of 1999 during the pre-BMP period was considered part of the summer runoff period because the majority of the snowmelt had occurred in the preceding two months. Conversely, May of 2001 during the post-BMP period was considered part of the spring runoff period because the snow pack runoff was still apparent.

Average concentrations were calculated by grouping the data by season (i.e., summer, fall or spring) and performing an arithmetic mean on the grouped data. Tables 8 (pre-BMP) and 9 (post-BMP) provide the concentration data grouped by season with the resulting average concentration for each season. These concentration values are also presented graphically;

Figures 48 through 59 present the average concentrations for the summer, fall and spring periods for each of the farms and each of the parameters.

Estimation of Nutrient Loads

Nutrient loads for the pre- and post-BMP periods were calculated by using the average seasonal nutrient concentrations and the calibrated hydrographs. In general, a concentration value of a pollutant (mass/volume) multiplied by a flow rate (volume/time) and the duration (time) of the flow rate provides a mass or load.

The runoff hydrographs as discussed in Section 7.1.1 were created using daily values of flow, or daily time-steps. To calculate the nutrient load, the daily flow value was multiplied by the average nutrient concentration (as discussed in Section 7.1.2) for that day and then multiplied by the duration of a day. Therefore, nutrient loads were calculated on a daily increment. The daily nutrient loads were then summed for defined periods to either produce a seasonal load or a pre- or post-BMP load.

The seasonal nutrient loads are charted as bar charts with the runoff hydrographs, as produced in Section 7.1.1. The runoff hydrographs depict the seasonal flow trends whereas the pollutant loads, as bar charts, depict the mass of pollutants discharged from the farmstead and areas upstream of the farmstead during each seasonal period. The pre- or post-BMP period pollutant loads can be calculated by summing the mass of pollutant from each of the seasonal periods. Both the pre- and post-BMP periods were 13 months. The hydrographs and seasonal load bar charts are presented in Figures 60 through 83. The charts are organized by farm: Rohe farm, Guptill farm and then Leubner farm. For each farm, the post-BMP load charts are presented immediately after the pre-BMP charts for each parameter for the purposes of comparing the pre- and post-BMP data. For example, Figure 60 presents the pre-BMP TSS seasonal loads and Figure 61 presents the post-BMP TSS seasonal loads.

Comparison of Water Quality Data from Upstream and Downstream of Each Farm

The intent of the sampling and monitoring program was to measure the effects of BMPs; therefore, it was originally proposed to sample water quality downstream of the BMPs only. However, during the course of the project questions evolved regarding the amount of solids and nutrients originating upstream of the farmsteads (i.e., upstream of the BMPs). In order to establish solids and nutrients levels upstream of the farms, water quality samples were taken from upstream locations. A full matching set of upstream samples were not taken due to budgetary constraints. However, the data collected from the upstream sampling locations were used to estimate the solids and nutrient loads originating upstream of the farmsteads and from the farmsteads. Though this data was limited, its intent was to give an indication of the magnitude

of change in water quality as the receiving waters flow passed the farmsteads.

In the case of the Guptill farm, the farmstead was truly at the headwaters of the creek. In the absence of an appropriate upstream sampling location, samples were not taken.

In the case of the Rohe farm, the upstream area is mostly forested land with some haylots. The upstream solids and nutrients concentrations were always lower than the downstream concentrations, as depicted in Tables 6 and 7. This limited data set suggests that the farmstead was the major contributor of solids and nutrients.

In the case of the Luebner farm, the upstream area is mainly haylot and rural residential units. The upstream solids and nutrients concentrations were always lower than downstream concentrations, as depicted in Tables 6 and 7; however the difference between upstream and downstream concentrations was not as great as observed at the Rohe farm. Nevertheless, the limited data set suggests that the Luebner farm was the major contributor of solids and nutrients to the receiving water.

7.1.5 Comparison of Ortho-Phosphorus and Total Phosphorus

Phosphorus is a nutrient found in many forms. Ortho-phosphorus is the most reactive (biologically accessible) form of this nutrient and is considered by most investigators to be 100 percent biologically available. Thus, the higher the level of ortho-phosphorus in the receiving water, the more food is readily available for immediate use by algae and plants. Ortho-phosphorus includes dissolved inorganic phosphorus, some phosphorus associated with small particles, and some organic phosphorus. Total phosphorus is the measurement of all forms of phosphorus including ortho- phosphorus. Total phosphorus includes dissolved inorganic phosphorus, phosphorus in organic material, and phosphorus associated with particulate material

The ratio of ortho-phosphorus to total phosphorus is important in that it provides a relationship between the amount of phosphorus which is soluble and readily available for plant uptake and that which is bound to particulate matter and must be transformed in the phosphorus cycle before it can become soluble and available for plant uptake.

Water quality monitoring in the tributaries of Onondaga Lake performed by the Onondaga County Department of Water Environment Protection (WEP) indicates that the ratio of ortho-phosphorus to total phosphorus ranges from 1% to 25%. The ratio of ortho-phosphorus to total phosphorus found during this project ranged from 25% to 75% in the pre-BMP condition and 23% to 33% in the post-BMP condition. This difference is likely due to the proximity of the EBP sampling locations to the farmstead as compared the WEP sampling locations, which are located within the Syracuse City limits. The EBP water quality sampling locations were likely directly affected by cow manure from the farmstead. Additionally the ratio of ortho-phosphorus

to total phosphorus decreased from the pre-BMP to the post-BMP condition, suggesting that less cow manure was reaching the receiving water and sampling location.

Cow manure can contain as much as 50% soluble phosphorus (Powell et al., 1999) and can become more soluble and mobile under wet conditions (Scott et al., 1998).

Based on these data it appears that the phosphorus originating from the farmsteads is relatively soluble and may become more soluble as it resides within the riparian zone of the streambeds near the farmsteads. Once this phosphorous reaches the receiving water the soluble form is taken up by plants and microbes and assimilated into organic phosphorus, which is less soluble. Therefore soluble forms of phosphorus likely exist in the upper reaches of the watershed (near the EBP sampling locations) and transform to less soluble forms as it reaches the sampling locations sampled by WEP within the city. This finding illustrates the importance of understanding the stream hydrology and the phosphorus cycle within the tributaries as part of the determining the impact of phosphorus from farmsteads on Onondaga Lake.

7.1.6 Weather Patterns and Flow Rates at the Farms

The three farms are within 30 miles of Syracuse and experience generally similar weather conditions. The Leubner farm is at the highest elevation and therefore tends to be the coolest with the latest occurring spring runoff period. However, average rain and snow amounts do not differ significantly among the farms.

The pre-BMP sampling began during May of 1999, by which time the spring runoff had abated and the summer weather pattern had begun. The summer of 1999 was characterized as a very dry period with few significant rain events. During the period from May through September, approximately 5.8 inches of rain fell, which was 9.2 inches below normal. During the period from October through December, approximately 12.5 inches of rain/snow fell, which was approximately 1 inch below normal. Snowfall during the winter of 1999-2000 was approximately 86 inches, which was 33 inches less than normal. A cooler and rainier spring than normal during 2000 extended the spring runoff season well into May. Pre-BMP sampling concluded at the end of May 2000 when construction of the BMPs started.

Due to lack of significant rainfall during the summer of 1999, base flows in the tributaries to Onondaga Lake were significantly lower than normal. Flows during the fall of 1999 and spring of 2000 were only marginally lower than normal.

The post-BMP sampling began during November of 2000, after a relatively normal fall season during which time approximately 8 inches of rain fell. The winter of 2000-2001 was one of the snowiest winters on record with 191 inches of snow (72 inches above normal). The spring run-off period of 2001, however, was relatively normal, beginning with some thaw periods in

February and lasting into April. The summer and fall seasons of 2001 were relatively normal with a total of 19 inches of rain, which was approximately 2 inches below normal.

7.1.7 Rohe Farm

Pollutant concentrations significantly decreased from the pre-BMP sampling period to the post-BMP sampling period at the Rohe farm. The pollutant concentrations for the pre- and post-BMP sampling periods are presented in Tables 6 and 7 respectively. Pollutant concentrations from each sampling event were ranked using the Wilcoxson Rank-Sum Test. This comparison approach (alpha = 0.05, 95% confidence) indicates a significant reduction in concentration from the pre-BMP sampling to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced the concentration of pollutants discharging from the Rohe farm.

At the Rohe farm during the pre-BMP sampling, approximately 1,000 lbs of total phosphorus discharged from the farmstead and areas upstream of the farmstead. Based on upstream sampling, approximately 135 lbs of total phosphorus originated from the pasture and forested land upstream of the farmstead; therefore, approximately 865 lbs would have discharged from the farmstead itself. As depicted in Figure 64, during the pre-BMP sampling period there was very little seasonal variation between total phosphorus loads to the creek. Although flow rates increased during the spring run-off period, total phosphorus loads did not increase as a result of the decreasing total phosphorus concentrations during this period. This is consistent with the types of point source pollution found on the Rohe farm before the implementation of the BMPs. Typically, point source pollution as found on the Rohe Farm dilutes with increasing flow.

During the post-BMP sampling period at the Rohe farm approximately 400 lbs of total phosphorus discharged from the farmstead and areas upstream of the farmstead. Based on upstream sampling, approximately 135 lbs of total phosphorus originated from the pasture and forested land upstream of the farmstead; therefore approximately 265 lbs would have discharged from the farmstead itself.

Based on the total phosphorus loads to the creek from the farmstead during the pre- and post-BMP sampling periods there was approximately a 70% reduction in total phosphorus load from the pre-BMP sampling period to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced phosphorus loads from the Rohe farm.

Ortho-phosphorus followed the same seasonal trends as total phosphorus with approximately 760 lbs and 110 lbs of ortho-phosphorus discharged from the farmstead and areas upstream of the farmstead during the pre- and post-BMP samplings periods, respectively. Based on upstream sampling, approximately 20 lbs of ortho-phosphorus originated from the pasture and forested

land upstream of the farmstead during both the pre- and post-BMP sampling periods. This equates to approximately 740 lbs and 90 lbs of ortho-phosphorus discharged from the farmstead during the pre- and post-BMP samplings periods, respectively, or an 88% reduction in ortho-phosphorus load as a result of BMP implementation at the Rohe farm.

TKN followed a slightly different trend than total phosphorus. During the pre-BMP sampling period the largest load discharging from the farmstead and areas upstream of the farmstead occurred during the spring runoff period, but during the post-BMP sampling period the largest load of TKN occurred during the summer season. In fact, during the summer months of the pre- and post-BMP sampling periods, TKN loads were similar. However, on a pre-BMP versus post-BMP basis there was a 68% reduction in TKN load as a result of BMP implementation at the Rohe farm. Approximately 3,170 lbs and 1,240 lbs of TKN discharged from the farmstead and areas upstream of the farmstead during the pre- and post-BMP samplings periods, respectively. Based on upstream sampling, approximately 340 lbs of TKN originated from the pasture and forested land upstream of the farmstead during both the pre- and post-BMP sampling periods. This equates to approximately 2,830 lbs and 900 lbs of TKN discharged from the farmstead during the pre-BMP and post-BMP periods, respectively.

7.1.8 Guptill Farm

Pollutant concentrations significantly decreased from the pre-BMP sampling period to the post-BMP sampling period at the Guptill farm. The pollutant concentrations for the pre- and post-BMP sampling periods are presented in Tables 6 and 7 respectively. Pollutant concentrations from each sampling event were ranked using the Wilcoxson Rank-Sum Test. This comparison approach (alpha = 0.05, 95% confidence) indicates a significant reduction in concentration from the pre-BMP sampling to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced the concentration of pollutants discharging from the Guptill farm.

At the Guptill farm during the pre-BMP and post-BMP sampling periods, approximately 1,700 lbs and 684 lbs of total phosphorus discharged from the farmstead, respectively. It can be assumed that the entire load discharged from the farmstead, since the farmstead was at the upper reaches of the watershed and there was no contributing flow from upstream of the farmstead. As depicted in Figures 72 and 73, during both sampling periods, most of the total phosphorus load discharged during the spring runoff period. This was likely due to the dispersed and accumulated manure throughout the farmstead that was flushed during the spring runoff periods. Based on the total phosphorus loads to the creek from the farmstead during the pre- and post-BMP sampling periods there was approximately a 61% reduction in total phosphorus load from the pre-BMP sampling period to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced

phosphorus loads from the Guptill farm. The greatest reduction in total phosphorus occurred during the spring runoff period; however, the spring runoff load during the post-BMP sampling period was much higher than during the other seasons. It is likely that throughout the next few years as the nutrients in the accumulated manure are flushed or harvested from the creek area that this trend of decreasing total phosphorus loads will continue.

Ortho-phosphorus followed the same seasonal trends as total phosphorus with approximately 350 lbs and 152 lbs of ortho-phosphorus discharged from the farmstead during the pre- and post-BMP samplings periods, respectively. This equates to approximately a 57% reduction in ortho-phosphorus load as a result of BMP implementation at the Guptill farm.

TKN followed the same seasonal trends as total phosphorus and ortho-phosphorus with approximately 10,400 lbs and 2,174 lbs of TKN discharged from the farmstead during the pre- and post-BMP samplings periods, respectively. This equates to approximately a 79% reduction in TKN load as a result of BMP implementation at the Guptill farm.

7.1.9 Leubner Farm

Pollutant concentrations significantly decreased from the pre-BMP sampling period to the post-BMP sampling period at the Leubner farm. The pollutant concentrations for the pre- and post-BMP sampling periods are presented in Tables 6 and 7 respectively. Pollutant concentrations from each sampling event were ranked using the Wilcoxson Rank-Sum Test. This comparison approach (alpha = 0.05, 95% confidence) indicates a significant reduction in concentration from the pre-BMP sampling to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced the concentration of pollutants discharging from the Leubner farm.

At the Leubner farm during the pre-BMP sampling, approximately 847 lbs of total phosphorus discharged from the farmstead and areas upstream of the farmstead. Based on upstream sampling, approximately 48 lbs of total phosphorus originated from the haylots and residential properties upstream of the farmstead; therefore, approximately 799 lbs would have discharged from the farmstead itself. As depicted in Figure 81, most of the total phosphorus load discharged during the summer runoff period. This was likely due to the point source discharges from the stall barn and drain tile from the bunk silage area, which tend to run "hot" during the summer months and less so in the fall and spring. The relatively high spring runoff load was likely the result of the dispersed and accumulated manure in the grazing (loafing) field adjacent to the creek that was flushed during the spring runoff period. This is consistent with the type of nonpoint source pollution such as the loafing area found on the Leubner farm before the implementation of the BMPs. Typically, nonpoint source pollution does not dilute with increasing flow.

During the post-BMP sampling period at the Leubner farm approximately 407 lbs of total phosphorus discharged from the farmstead and areas upstream of the farmstead. Based on upstream sampling, approximately 48 lbs of total phosphorus originated from the he haylots and residential properties upstream of the farmstead; therefore approximately 359 lbs would have discharged from the farmstead itself. The smallest reduction in total phosphorus occurred during the spring runoff period; it is likely that throughout the next few years as the nutrients in the accumulated manure are flushed or harvested from the loafing area the trend of decreasing total phosphorus loads will continue.

Based on the total phosphorus loads to the creek from the farmstead during the pre- and post-BMP sampling periods there was approximately a 55% reduction in total phosphorus load from the pre-BMP sampling period to the post-BMP sampling period. Presumably the only changes at the farm were the implementation of the BMPs, which suggests the BMPs successfully reduced phosphorus loads from the Rohe farm.

Ortho-phosphorus followed the same seasonal trends as total phosphorus with approximately 498 lbs and 165 lbs of ortho-phosphorus discharged from the farmstead and areas upstream of the farmstead during the pre- and post-BMP samplings periods, respectively. Based on upstream sampling, approximately 13 lbs of ortho-phosphorus originated from the pasture and forested land upstream of the farmstead during both the pre- and post-BMP sampling periods. This equates to approximately 485 lbs and 152 lbs of ortho-phosphorus discharged from the farmstead during the pre- and post-BMP samplings periods, respectively, or a 69% reduction in ortho-phosphorus load as a result of BMP implementation at the Leubner farm.

TKN followed the same seasonal trends as total phosphorus and ortho-phosphorus with approximately a 50% reduction in TKN load as a result of BMP implementation at the Leubner farm. Approximately 5,898 lbs and 2,983 lbs of TKN discharged from the farmstead and areas upstream of the farmstead during the pre- and post-BMP samplings periods, respectively. Based on upstream sampling, only 61 lbs of TKN originated from the haylots and residential properties upstream of the farmstead during both the pre- and post-BMP sampling periods. This equates to approximately 5,837 lbs and 2,922 lbs of TKN discharged from the farmstead during the pre-BMP and post-BMP periods, respectively.

7.1.10 Cost Benefit Relationship of Nutrient Reduction from Farmsteads versus METRO

The cost of BMP construction and implementation on each farm was approximately $45,000. Most of the funds were directed toward structural BMPs that were designed to control point source pollution from manure handling and animal feeding operations. Investments were also made in creating buffer zones between the receiving waters and active livestock areas and manure handling stations. Based on evaluations of the water quality risks at these farms, it was decided during the early stages of the project that targeting these sources of pollution would

provide the greatest return on the investment in terms of nutrient reductions.

Total phosphorus reductions from the three farms ranged from approximately 400 to 1,000 pounds and TKN reductions ranged from approximately 900 to 8,200 lbs. Nutrient loads from the pre- and post-BMP periods and percent removals are presented below.

	Pre-BMP (pounds)	Post-BMP (pounds)	Reduction (pounds)	Percent Removal
Rohe Farm				
Total Phosphorous	865	265	600	70%
Total Kjeldahl Nitrogen	2,830	900	1,930	68%
Guptill Farm				
Total Phosphorous	1,700	684	1,016	61%
Total Kjeldahl Nitrogen	10,400	2,174	8,226	79%
Leubner Farm				
Total Phosphorous	799	359	440	55%
Total Kjeldahl Nitrogen	5,837	2,922	2,915	50%

These reductions equate to approximately $45 to $112 per pound of total phosphorus removed per year and $5 to $50 per pound of TKN removed per year.

As a frame of reference, Onondaga County is investing approximately $125 million at the Metropolitan Sewage Treatment Plant (METRO) for phosphorus and ammonia removal during the period from 1996 to 2015. The expected annual reductions in phosphorus and ammonia are 66,500 pounds and 550,000 pounds, respectively. This equates to approximately $1,900 per pound of total phosphorus removed per year and $230 per pound of ammonia per year.

It is important to note that these estimates of reductions and their associated costs are only first order estimates and that several broad assumptions were made to make these estimates. The intent of making such assumptions and estimates is to begin to relate the cost benefit relationship of pollutant removal in the urban setting (i.e. METRO) as compared to the agricultural setting.

These unit costs only represent capital costs, or estimated capital costs in the case of METRO, for the construction of the treatment practices; they do not include annual operation and maintenance. If annual operation and maintenance costs were considered, then the unit cost for phosphorus and TKN/ammonia removal would increase. The unit cost increase would be greater for METRO than the farmsteads because of the relative complexity of the practices; the practices selected for the farmsteads are extremely simple technology as compared to the advanced treatment technology at the wastewater treatment plant. Additionally, TKN was measured at the farms and ammonia-N is measured at the wastewater treatment plant. If it were assumed that

50% of the TKN was ammonia-N, then it would be $10 to $100 per lb of ammonia-N removed per year from the farms.

It appears that removal of nutrients, in particular phosphorus, at the farmstead may be more cost effective than removal of nutrients at METRO, but several other factors, such as relative quantity of nutrient, proximity of pollutant source to Onondaga Lake, and longevity of BMPs should be considered.

One such factor is the relative quantity of nutrients from these sources. For example, if expected phosphorus removals range from 400 to 1,000 pounds of phosphorus from a farmstead per year and there are approximately 50 active dairy farms in the watershed that have not had BMPs installed, then the quantity of total potential phosphorus removal is between 20,000 lbs and 50,000 lbs, which is less than the expected amount of phosphorus removal at METRO (66,500 pounds). In terms of TKN, the quantity of potential removal from the active farms may range between 45,000 and 410,000 pounds per year. If it is assumed that 50% of the TKN is ammonia-N, then there would be 22,500 to 205,000 pounds of total potential ammonia-N removal from the farms, which is also less than the expected amount of ammonia-N removal at METRO (550,000 pounds).

Another major difference between METRO and the farmsteads is their relative proximity to Onondaga Lake; METRO discharges directly into the lake whereas the farmsteads discharge at the upper reaches of the watershed. In newly developing TMDL pollutant trading scenarios (Bhimani, McDonald, Dennis, 2001), pollutants discharged further away from the "at risk receiving water" are discounted because they potentially have less of an effect due to assimilation and potential export from the watershed as a result of nutrient cycles.

Yet another major difference between METRO and the farmsteads is the relative setting in which these practices are operated and maintained. At METRO, due to regulatory compliance, proper operation and maintenance of the practices is more assured than at the farmsteads where there are no regulations for smaller farms and less far less stringent regulations for larger farms.

In summary, the farmsteads appear to be a genuine source of nutrient pollution that can be practically removed from the Onondaga Lake Watershed both in terms of quantity and cost effectiveness. The true cost benefit relationship may not be as attractive as the current unit cost portray due the aforementioned reasons; nevertheless this source of pollution should remain an important issue in the Onondaga Lake watershed management.

In addition to the nutrient pollution discharging from the farmstead, an equal or larger source of nutrient pollution may be from agricultural cropland runoff (Moffa and Associates, 1995). According to the Onondaga Lake watershed framework model (Moffa and Associates, 1995), as much as 275,000 pounds of phosphorus and 1,300,000 pounds of TKN may discharge from these croplands during a typical year. This will be corroborated through Round 2 of this project. The

cost associated with implementing cropland management techniques designed to reduce nutrient runoff from fields will be much lower than the cost associated with structural BMPs for the farmsteads, however the reductions may not be as great. Again, the will be corroborated through Round 2 of this project.

7.2 Urban BMPs

7.2.1 Stormwater Vortex Unit

The stormwater vortex unit was monitored for just over a one-year period from March 2001 until May 2002, during which time approximately 40 inches of rain fell during the non-winter months. This equated to approximately 730,000 gallons of stormwater processed by the vortex unit. Also during this time approximately 100 cubic feet of material was removed from the vortex unit weighing an estimated 4,500 lbs. This equates to approximately 0.14 cubic feet, or 6 lbs of material captured per 1,000 gallons of stormwater processed. Most of the material removed from the vortex unit was sand and grit and organic material such as leaves and twigs. Relatively little trash was collected as a result of the grated catchbasins, which prevent trash from entering the stormwater conveyance system.

The vortex stormwater unit was installed in October of 2000. Only visual inspections were made from October 2000 to March of 2001 when the first cleaning occurred. Cleaning of the unit occurred after March 2001 on an as needed basis. Table 10 shows the dates of the cleanings, the amount of stormwater volume processed between cleanings and the amount of material removed from the unit.

Water quality sampling was conducted on six storm events beginning in July of 2001 and ending in April of 2002. However, due to non-representative sampling procedures and laboratory methods only samples collected during the sixth event are considered appropriate for influent versus effluent comparisons. During events 1 through 5 samples were taken with a US DH-81A sampler, which was specifically designed for sampling sediment in flowing water. Because there was some concern that the US DH-81A sampler was not taking representative samples of the sediment load, a Van Dorn sampler was used to sample during the last event. The amount and type of material collected during the sixth event with the Van Dorn sampler appeared to be significantly different than that collected with the US DH-81A during the first five events. A photo of the solids collected with the Van Dorn sampler from the influent and the effluent during event six are presented in Figure 90. Coarse, medium and fine grit (3 to 0.075 mm) were apparent in the influent while mostly fine grit (< 0.2 mm) and silt material were apparent in the effluent. In addition, the solids concentrations measured during the sixth event were the highest observed throughout the sampling effort thus suggesting that the Van Dorn sampler was collecting more solids in the sample than the US DH-81A sampler.

Figures 84 through 89 show the hyetographs and hydrographs from each of the six sampled storm events. Peak flows by event ranged from 0.3 cfs to 1.9 cfs. The peak flow of 1.9 cfs was generated from approximately 0.35 inches of rain falling in a 15 minute time period. This equates to a rain intensity of 1.4 inches per hours, which is equivalent to approximately one-half the intensity of the 1-year return frequency storm for the City of Syracuse. As a frame of reference the 4-ft diameter Downstream Defender® design flow rate is 0.75 cfs and the maximum capacity is 3.0 cfs. The design flow of 0.75 cfs was exceeded during three of the six sampled storm events. As discussed in Section 4.3.1, a 4-ft diameter unit was installed so that the design flow would be exceeded approximately once or twice a month for the purposes of sampling the unit while it operated at or near the design conditions.

Figure 89 shows the hyetograph and hydrograph for event six as well as the influent and effluent solids concentrations observed for the samples taken during this event. Flows began at approximately 9:15 am on April 25, 2002. Sampling equipment was prepared and ready for sampling in advance. Three influent/effluent sample pairs were taken at flow rates ranging from 0.4 to 0.75 cfs. As the first flows were observed, the first pair of samples were taken. As the flow rate peaked to near the design flow (0.75 cfs) the second pair of samples were taken. The third samples were taken on the falling limb of the hydrograph. Percent removal ranged from 26% to 93%. The first sample appeared to be representative of a first flush; solids concentrations in the influent were the highest observed throughout the entire sampling program. The corresponding percent removal was on the order of 93%. High percent removals are often associated with the first flush because this flush conveys waters laden with heavy solids and associated pollutants.

During events five and six floatable material (trash) was seeded into the influent. The floatable material consisted of cigarette butts, food wrappers, Styrofoam cups and milk cartons. The vortex unit was effective at removing this material; no seeded material was observed in the effluent. During the cleanings that followed events five and six all the seeded material except for the cigarette butts were recovered. This should not necessarily indicate that the unit is ineffective at capturing cigarette butts. In fact, based on field observations, the unit does capture cigarette butts, but because of their size finding cigarette butts during cleaning proved difficult.

On August 21, 2001 and September 3, 2002 solids were sampled from the sediment storage sump of the Downstream Defender®. Nine percent of the material in the sump was characterized as course sand, 53% of the material was characterized as medium sand and 38% characterized was as fine sand, silt and clay. This suggests that the majority of the material influent to this particular installation is medium sand and smaller and the material captured by this particular unit ranges from coarse to fine sized sand and smaller. This is not to say this units captures 100% of any particular size material, but rather based on the contents of the storage sump it has the ability to capture coarse to fine sized sand and smaller material.

Also on September 3, 2002 samples from the sediment storage sump were collected and analyzed for metals and phosphorus. These results are presented in Table 11. These results show that there are pollutants such as metals and phosphorous associated with the types of solids that the Downstream Defender® successfully captured. Pounds of associated pollutants were calculated based on the total quantity of material (solids) captured by Downstream Defender® throughout the duration of this study period and based on the assumption that this one sample was representative of the total mass of material captured. Of particular interest was chromium, cooper, lead and total phosphorus. Pounds of these pollutant removed during this study period were estimated to be:

- Chromium: 0.29 lbs
- Copper: 0.14 lbs
- Lead: 0.76 lbs
- Phosphorus: 0.95 lbs *

It is likely that the mass of phosphorus captured by the Downstream Defender® was significantly greater than 0.95 pounds. This is based on the fact that this sample represented solids captured during the summer months when nutrient concentrations are assumed to be low. It is expected that nutrient concentrations would be significantly higher if the sample were collected after the heavy autumn leaf load. During cleaning after the fall seasons, heavy layers of leaf litter were apparent.

Maintenance is key to success with any structural BMP designed to remove solids from stormwater. Onondaga County removed the solids from the unit on an as needed basis. It was a very simple operation with the vactor truck. Cleanout of the diversion manhole and the unit itself took approximately 15 minutes, which included maneuvering the truck into position near the unit, drawing material up with the suction pipe of the vactor truck and pressure washing the solids from the bottom and sides.

7.2.2 Vegetative Filter Strip

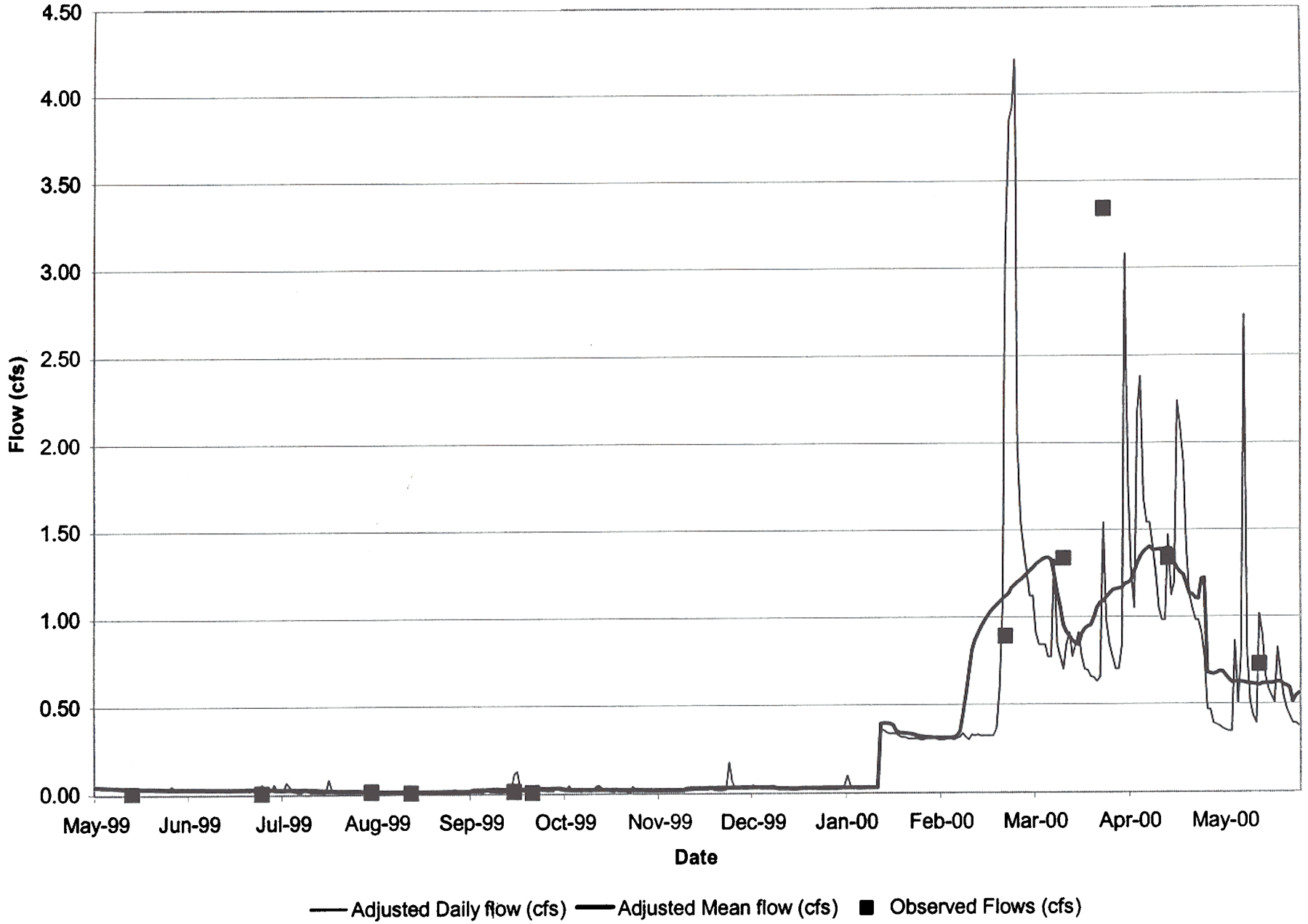
The vegetative filter strip was monitored for roughly five months from June 2001 until October 2001, during which time approximately 16.5 inches of rain fell. This equated to approximately 40,000 gallons of stormwater processed by vegetative filter strip.

The vegetative filter strip was installed in July of 2000. The vegetation was allowed to establish itself for approximately one year before the evaluation began.

Water quality sampling was conducted on six storm events beginning in June of 2001 and ending in October of 2001. Table 12 shows the data collected during these sampling events. For half the events sampled, the vegetative filter strip absorbed the stormwater and no effluent flow was apparent. During the other three sampling events, rainfall and the resulting parking lot runoff

were great enough to cause flow through the vegetative filter strip. It appears that the strip could absorb about one inch of rain before effluent flow was apparent; this is equivalent to approximately 3,000 gallons of stormwater. The vegetative filter strip appeared to be effective at removing solids during a flow through condition. However, concentrations of solids were relatively low. It also appeared that the vegetative filter strip was acting as a nutrient reservoir; releasing nutrients when stormwater flowed through the strip. Again, the nitrogen and phosphorus concentration in both the influent and effluent was very low. The source of the nutrient reservoir was likely from the compost bedding established for seeding.

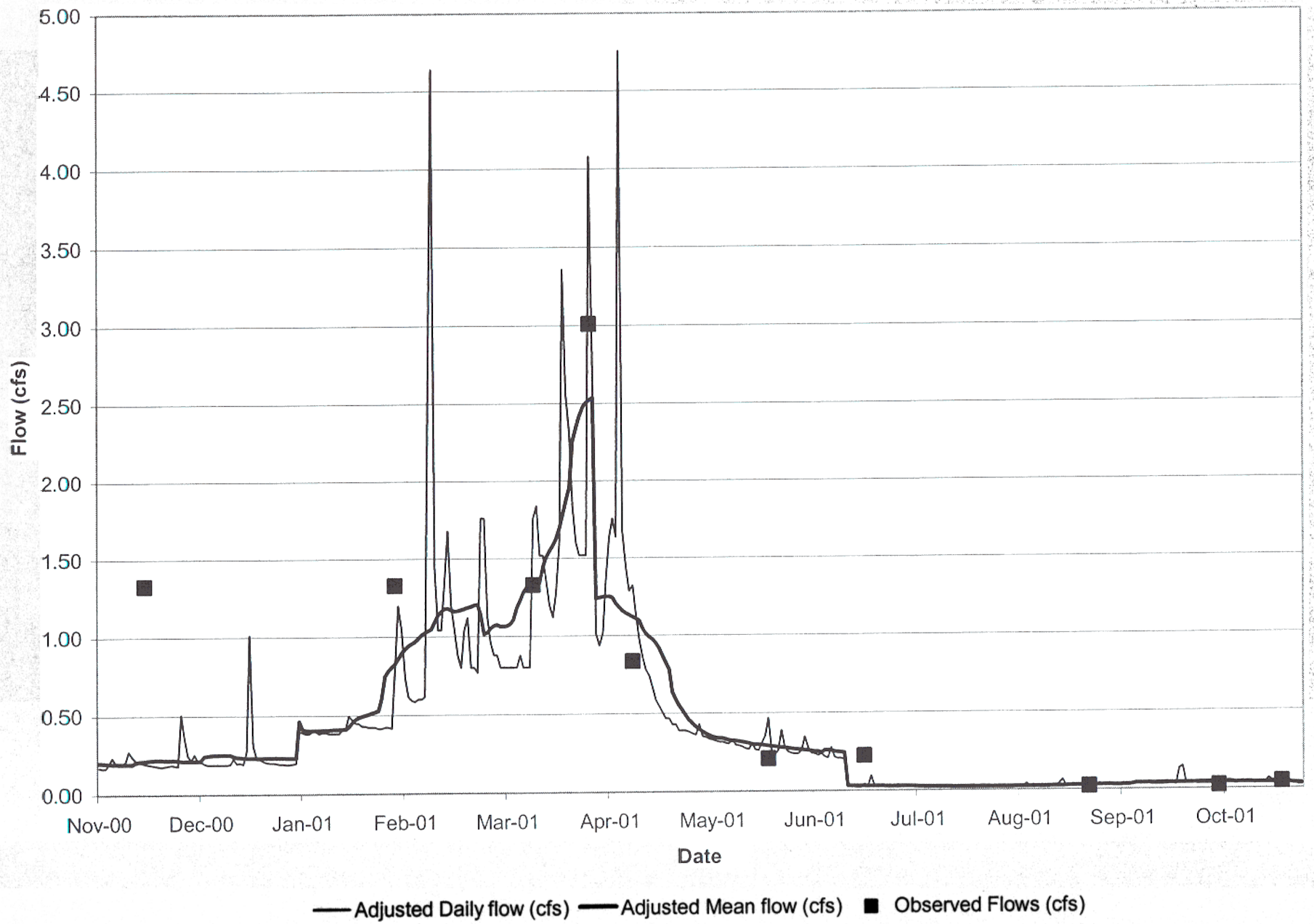
Maintenance on the vegetative filter strip is minimal. The grass is not cut; it is allowed to grow to its natural length, which is about two to three feet. Garbage does collect in the filter strip and maintenance crews pick up this garbage on a routine basis.



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph (calibrated)

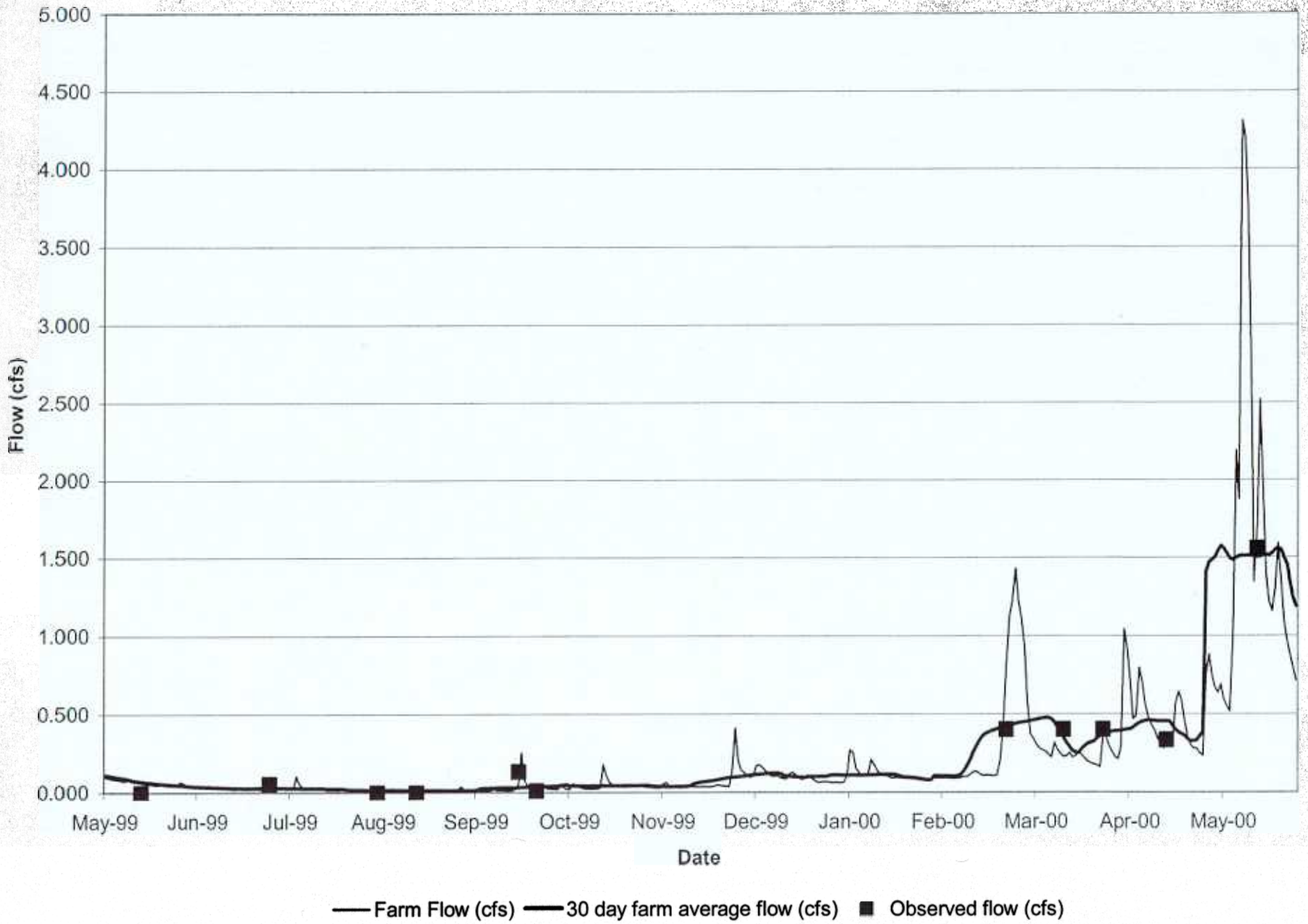
Figure 42



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph (calibrated)

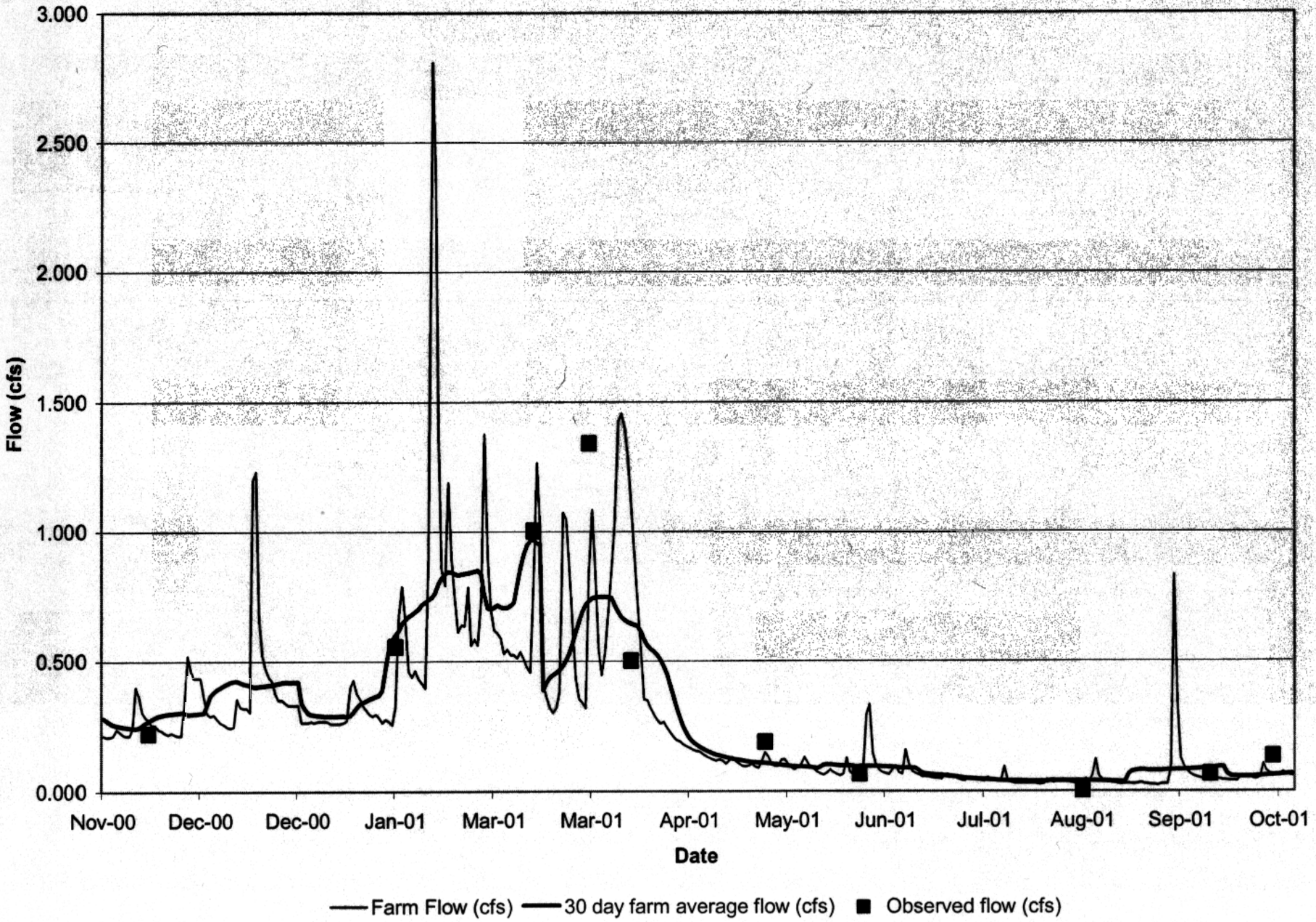
Figure 43



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph (calibrated)

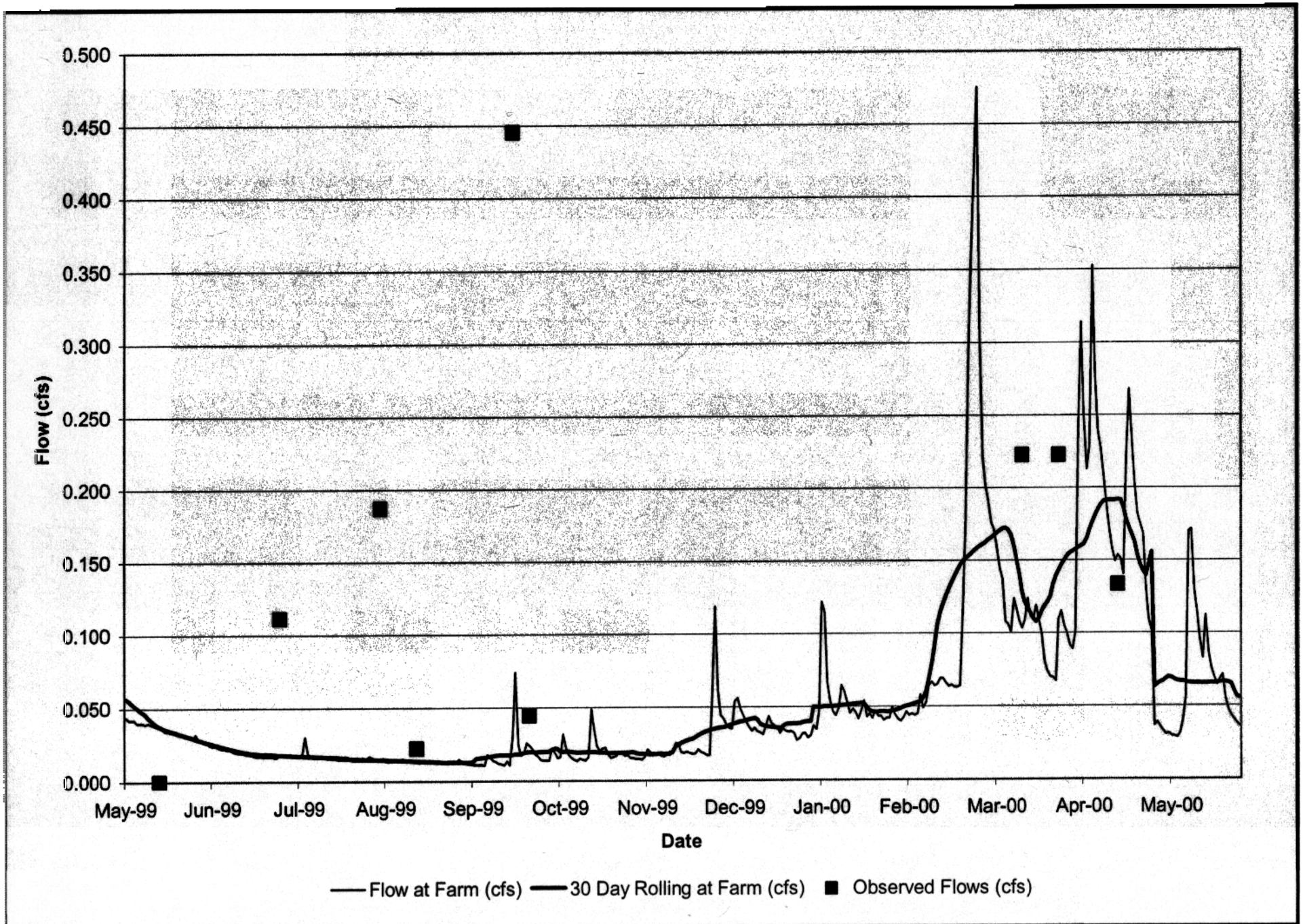
Figure 44



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph (calibrated)

Figure 45



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre-BMP Hydrograph (calibrated)

Figure 46

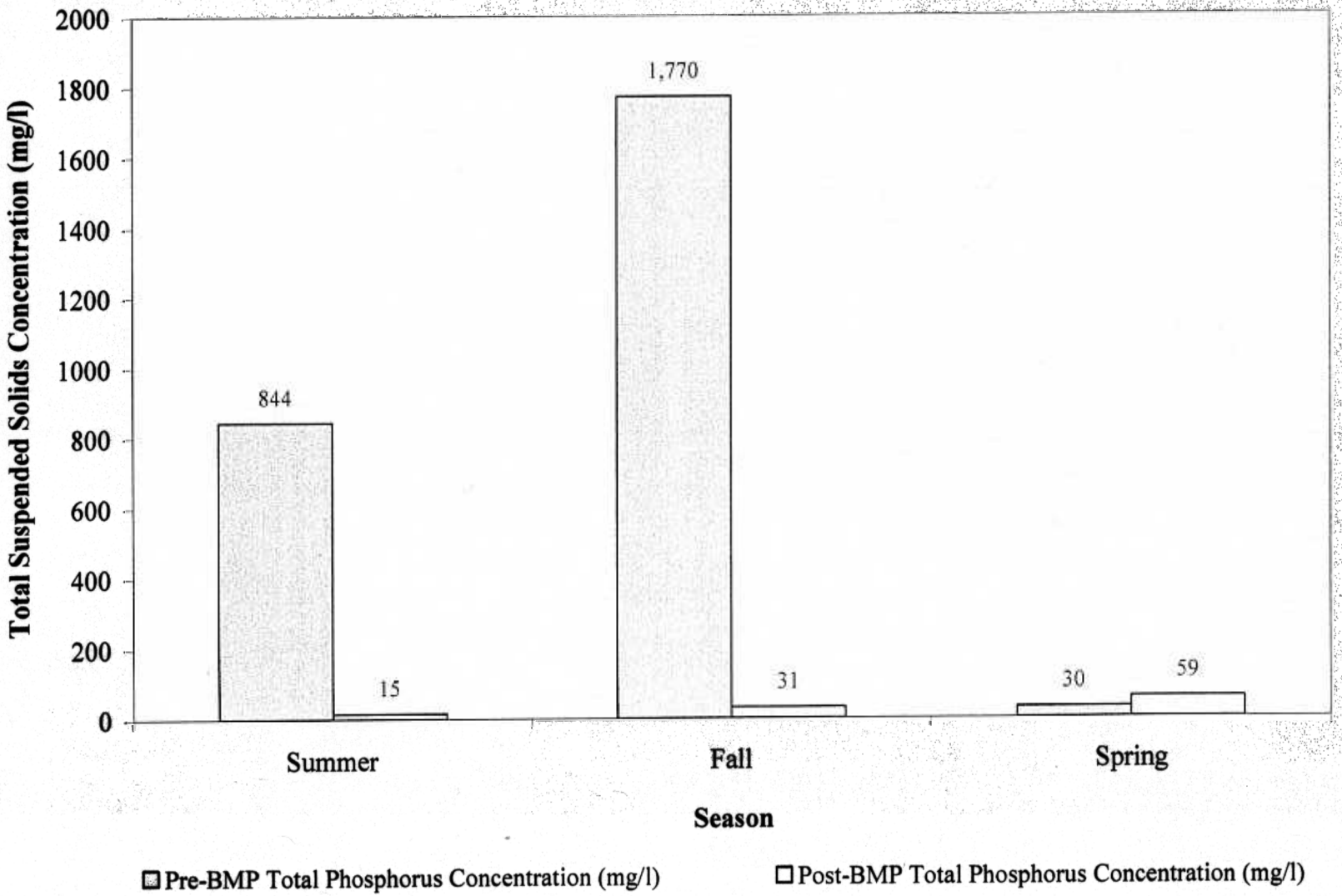
Month	Date	Rohe Farm					Guptill Farm					Leubner Farm				
		Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l
May	5/13/1999	0	450	4.24	0.89	0.68	0	980	2.85	0.86	0.06	0	8280	508	68.1	38.4
June	6/25/1999	2	1730	166	67	41.2	25	51	31	6.02	2.34	50	180	156	22	10.2
July	7/31/1999	5	325	11.2	26.5	23.4	0	1400	42.6	14.6	3.25	84	260	61.1	15.3	8.22
Aug	8/13/1999	2	870	10.1	1.51	NA	0	3700	356	54.4	NA	10	2120	330	59.6	NA
Summer Period Average			**844**	**48**	**24**	**22**		**1533**	**108**	**19**	**2**		**2710**	**264**	**41**	**19**
Sept	9/16/1999	5	2350	40.6	10.3	5.25	60	830	47.9	6.65	3.23	200	390	33.3	13.7	6.27
Sept	9/22/1999	2	1190	101	19.6	12.2	5	530	20.2	5.84	2.45	20	85	26.5	7.15	4.15
Fall Period Average			**1770**	**71**	**15**	**8.7**		**680**	**34**	**6**	**2.8**		**238**	**30**	**10**	**5.2**
Feb	2/25/2000	400	18	7.17	1.74	1.49	180	76	17.2	3.39	1.93	300	47	10.6	2.02	1.45
March	3/15/2000	600	7	2.97	0.16	0.05	180	68	1.85	0.32	0.06	100	71	29.7	3.84	1.71
March	3/28/2000	1500	66	2.98	0.51	0.26	180	533	34.1	3.35	0.6	100	63	17.2	2.92	1.91
April	4/18/2000	600	33	2.85	0.42	0.1	150	172	7.21	1.15	0.25	60	124	15.8	3.18	1.57
May	5/18/2000	325	26	1.27	0.19	0.11	700	1250	13.3	3.68	0.44	250	555	16.2	3.81	1.16
Spring Runoff Average			**30**	**3.4**	**0.60**	**0.40**		**419.8**	**14.7**	**2.38**	**0.66**		**172**	**17.9**	**3.15**	**1.56**

Month	Date	Rohe Farm					Guptill Farm					Leubner Farm				
		Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	Flow gpm	TSS mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l
November	11/15/2000	600	8.0	0.69	0.04	< 0.02	100	10	0.98	0.09	0.02					
January	1/30/2001	600	8.0	1.15	0.23	0.16	250	393	6.11	2.47	0.91		Not Sampled			
March	3/13/2001	600	71.0	6.42	0.79	0.54	450	1180	15.6	4.18	0.74					
March	3/30/2001	1350	40.0	2.53	0.88	0.56	600	897.0	10.8	2.92	0.64	85	433.0	16.6	3.71	1.1
April	4/12/2001	375	6.0	0.65	0.18	0.02	225	10.0	0.5	0.06	0.03	140	52.0	16.7	1.98	0.84
Spring Runoff Average			**31**	**2.7**	**0.52**	**0.32**		**620**	**8.3**	**2.4**	**0.58**		**243**	**16.7**	**2.8**	**1.0**
May	5/23/2001	93.5	35.0	4.51	1.41	0.76	85	87	1.13	0.39	0.13	95	55	11.5	1.88	1.22
June	6/21/2001	100	89	3.61	0.41	0.18	30	83	6.18	2.57	0.25	20	67.5	23.4	2.38	1.3
August	8/28/2001	No flow					0	264	5.34	1.89	1	10	154	9.95	3	1.84
September	10/6/2001	10	52.0	4.33	1.43	0.15	30	368	3.91	1.65	0.02	5	28	10.8	2.8	1.57
Summer Period Average			**59**	**4.2**	**1.1**	**0.36**		**201**	**4.14**	**1.6**	**0.35**		**76**	**14**	**2.5**	**1.5**
October	10/25/2001	20	14	1.09	0.44	0.03	60	1176	2.22	2.06	0.35	10	213	162	12.2	3.89
November	11/7/2001	20	30	2.75	1.01	0.09	60	720	3.1	1.8	0.11	10	112	60	5.6	3.1
Fall Period Average			**15.0**	**1.3**	**0.38**	**0.04**		**479**	**1.8**	**1.0**	**0.13**		**163**	**111**	**8.9**	**3.5**

Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Post-BMP Implementation Water Quality Data from Agricultural Sites

Table 9



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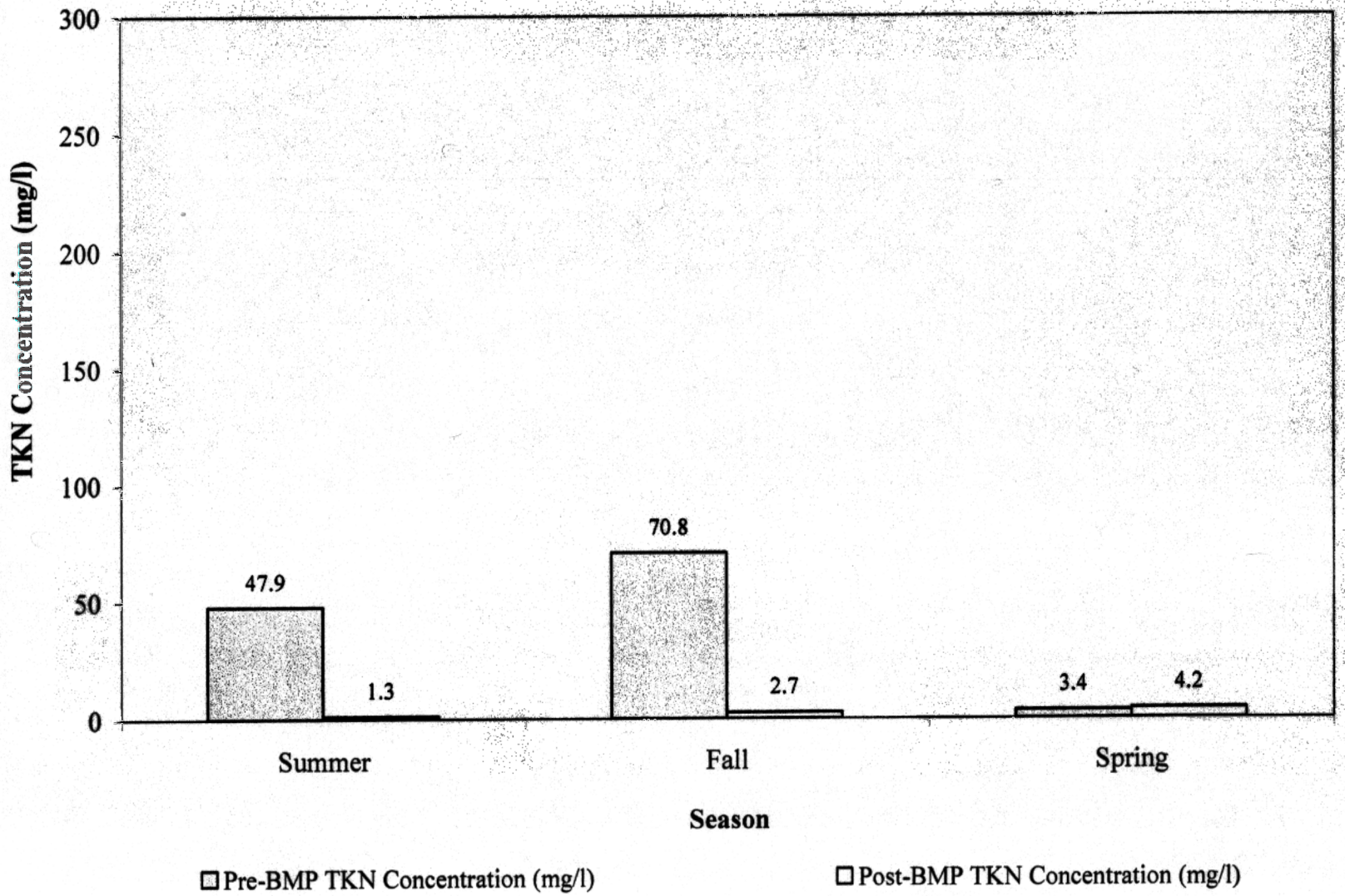
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre- and Post-BMP Total Suspended Solids (TSS) Concentrations

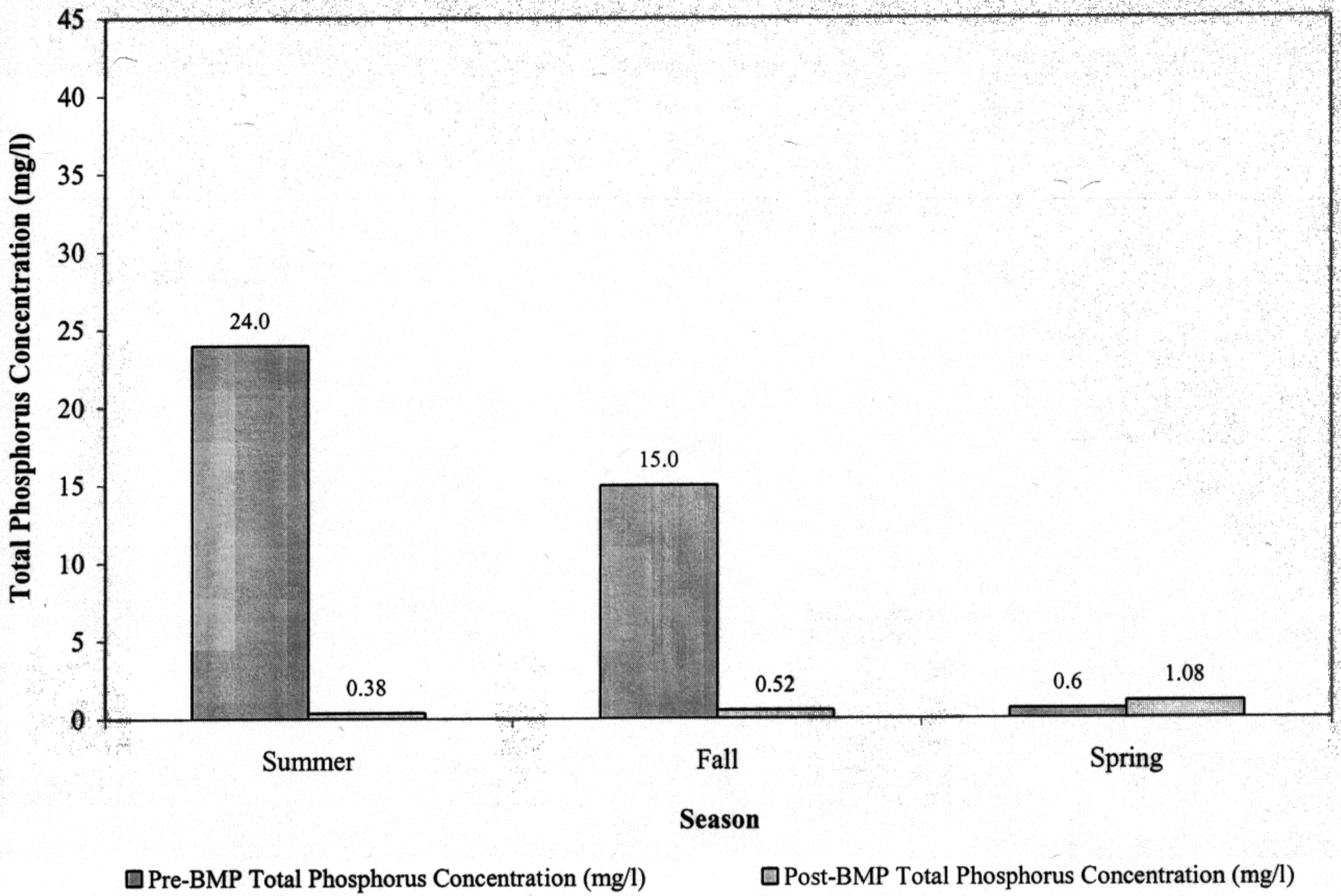
Figure 48



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre- and Post-BMP Total Kjeldhal Nitrogen (TKN) Concentrations

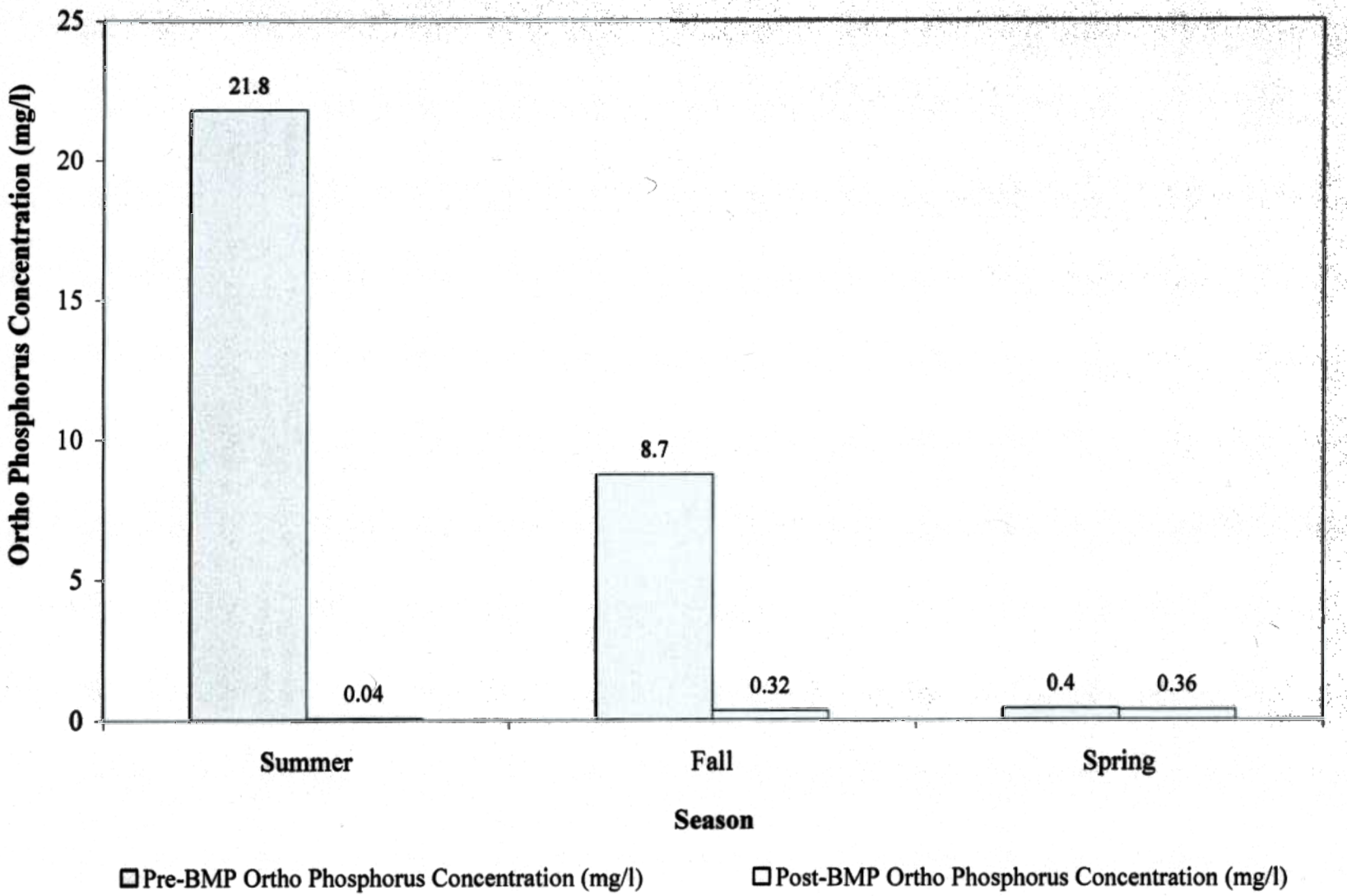
Figure 49



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre- and Post-BMP Total Phosphorus Concentrations

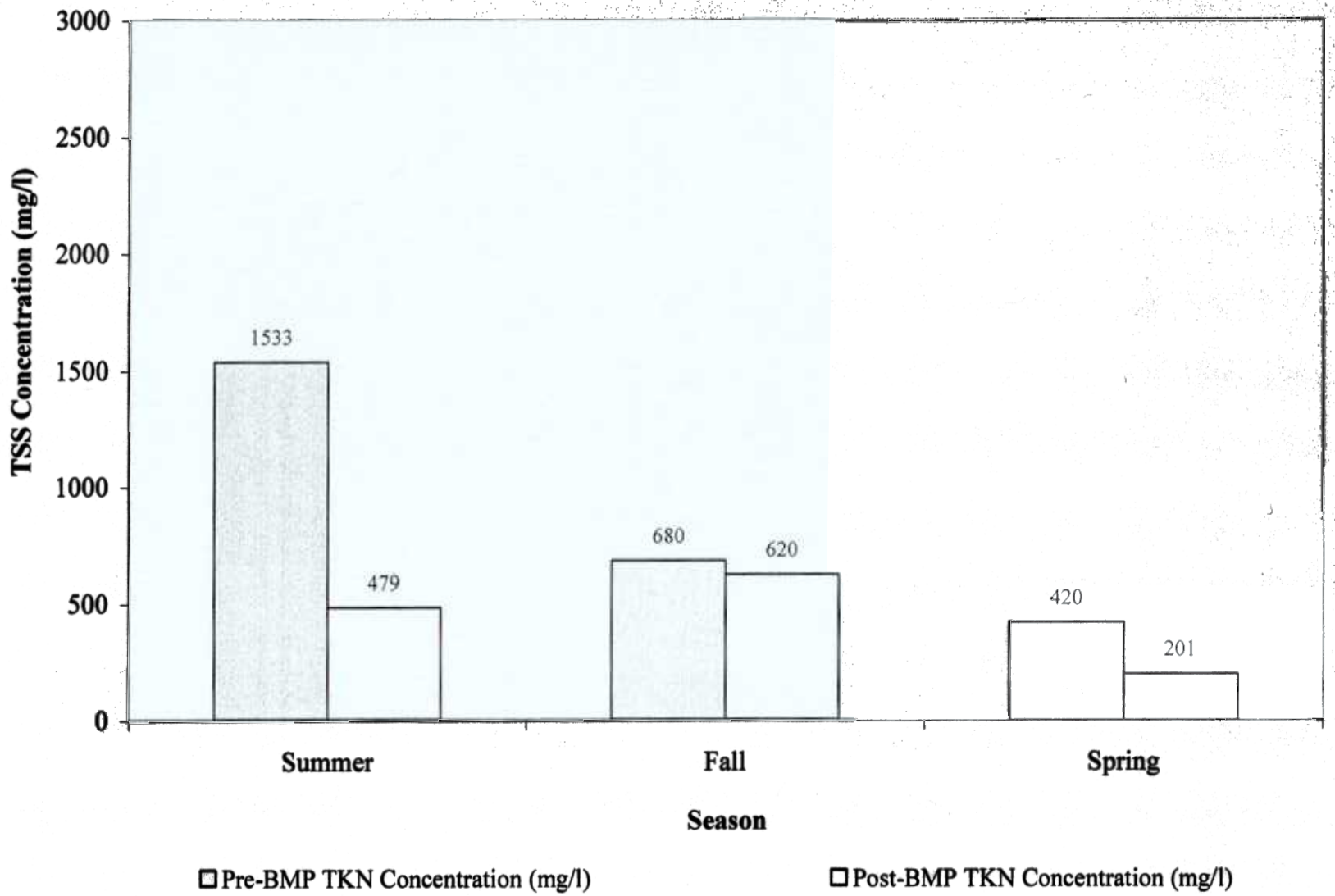
Figure 50



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre- and Post-BMP Ortho-Phosphorus Concentrations

Figure 51



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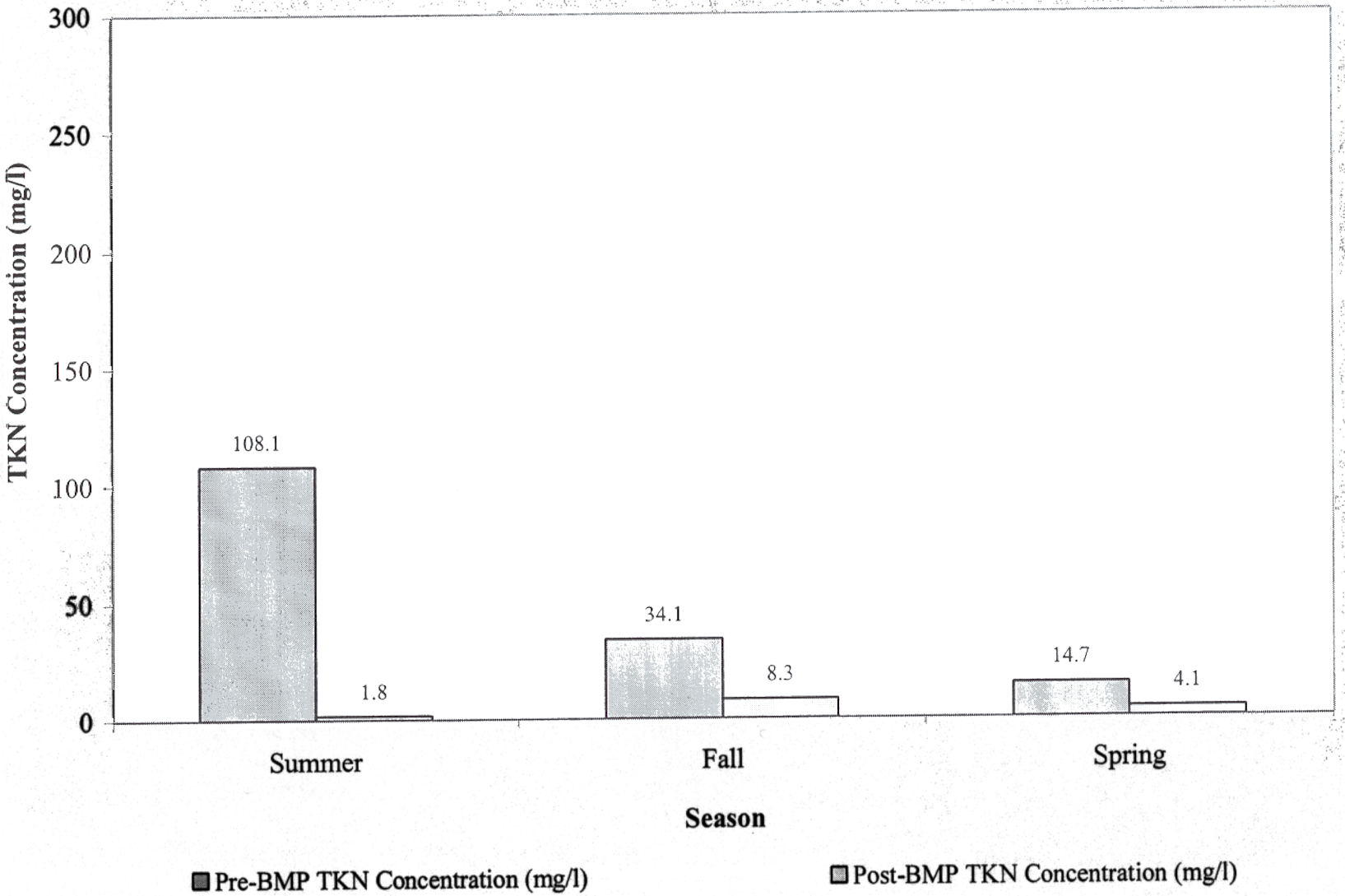
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP TSS Concentrations

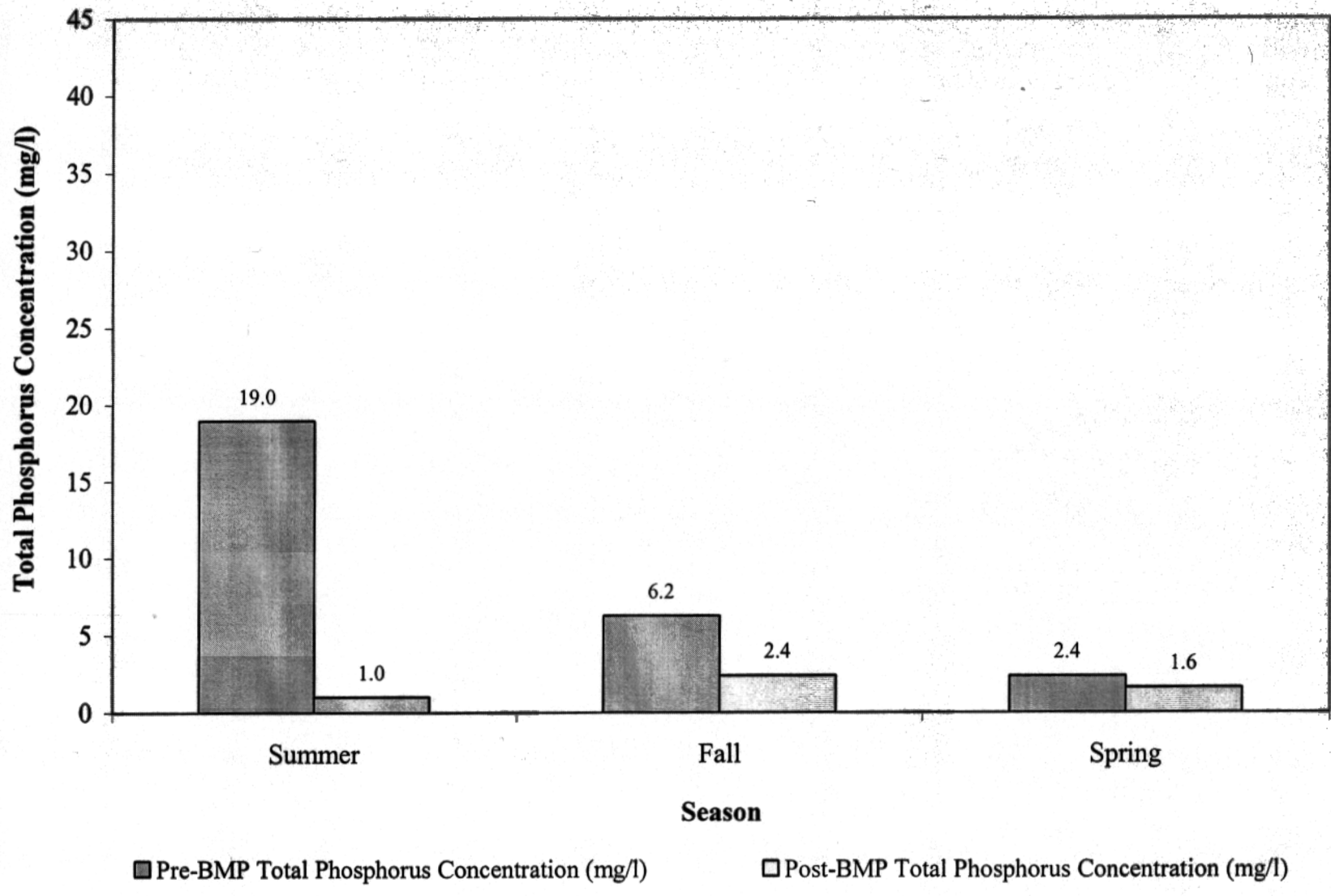
Figure 52



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP Total Kjeldhal Nitrogen (TKN) Concentrations

Figure 53



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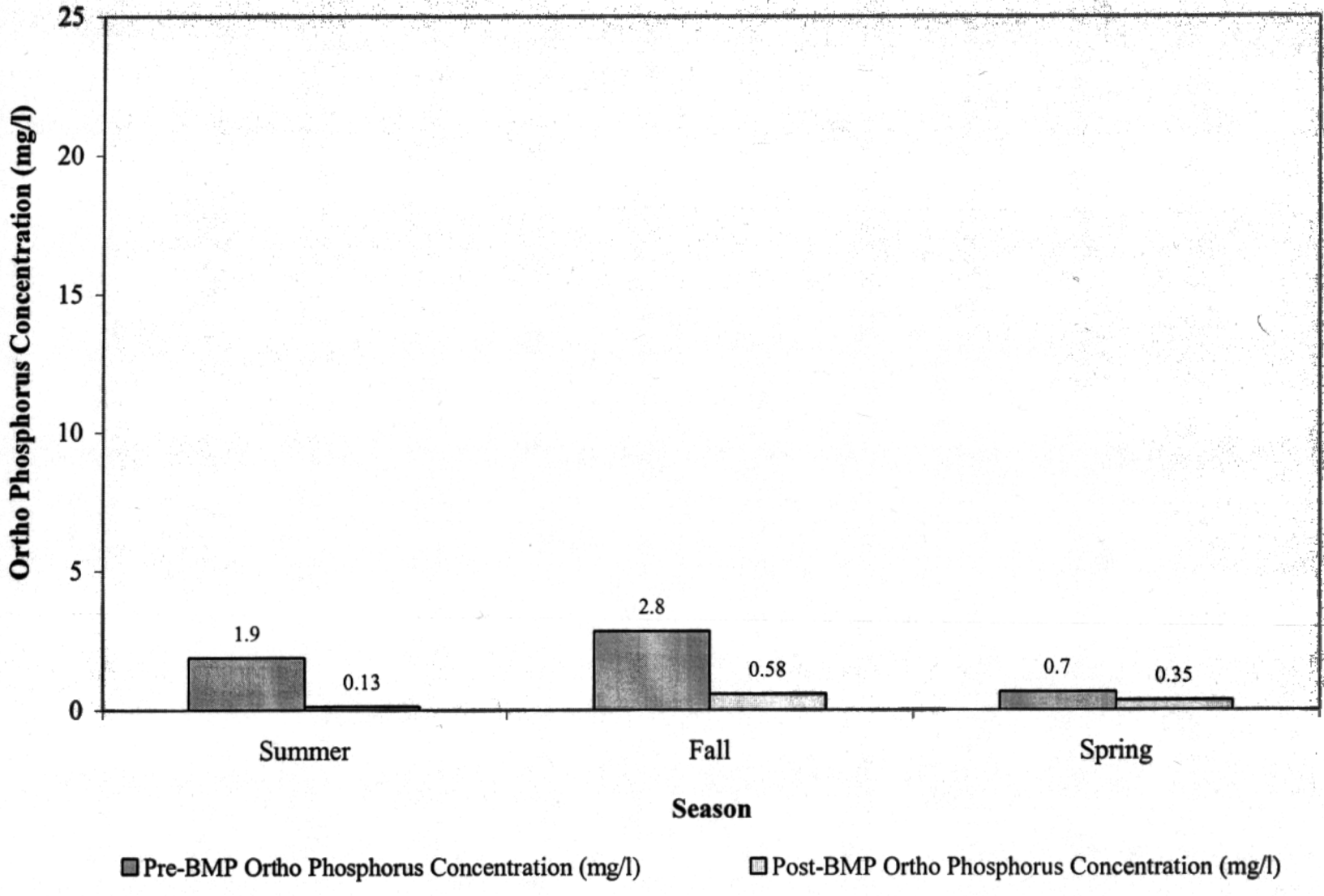
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP Total Phosphorus Concentrations

Figure 54



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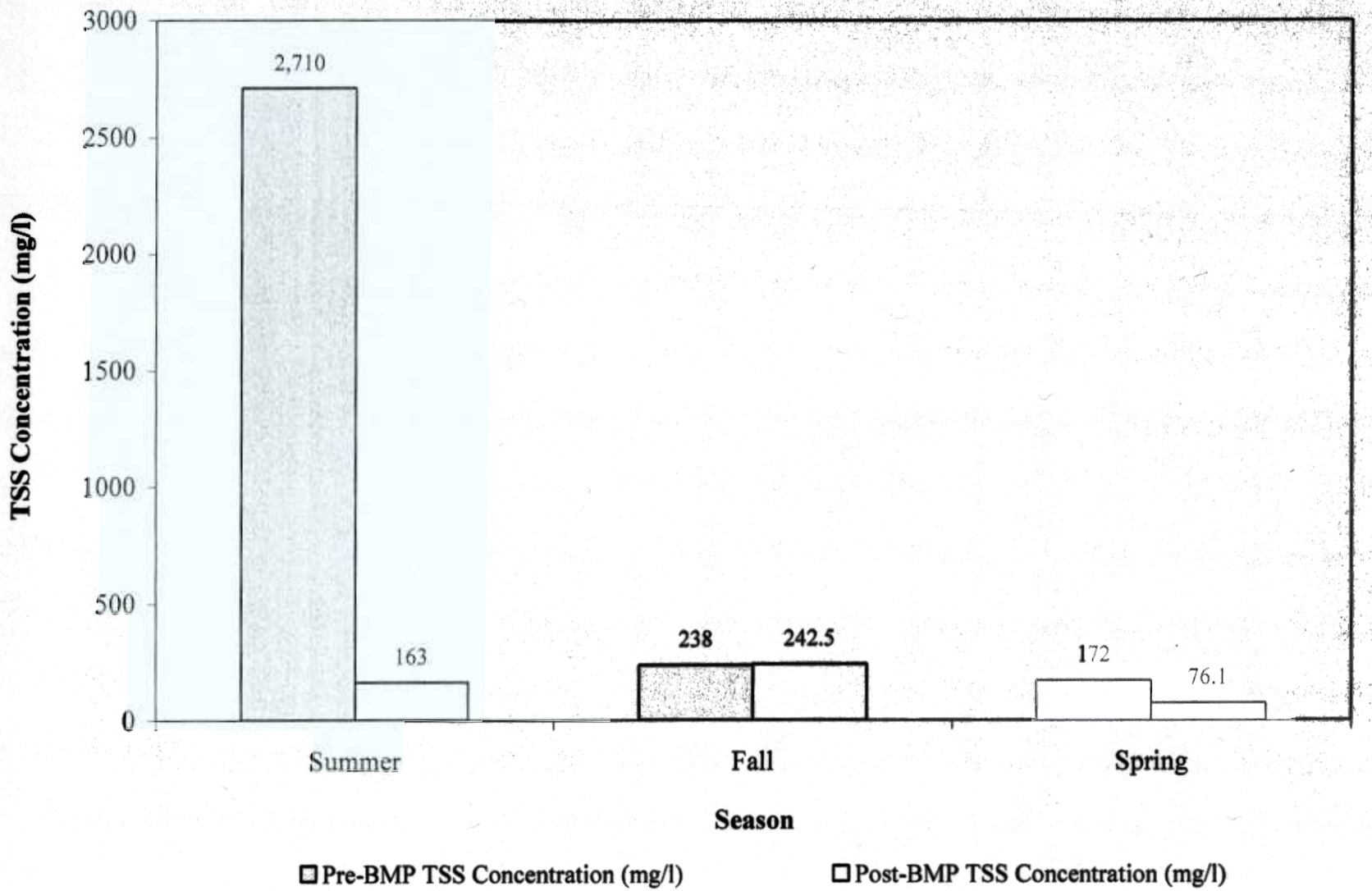
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP Ortho-Phosphorus Concentrations

Figure 55



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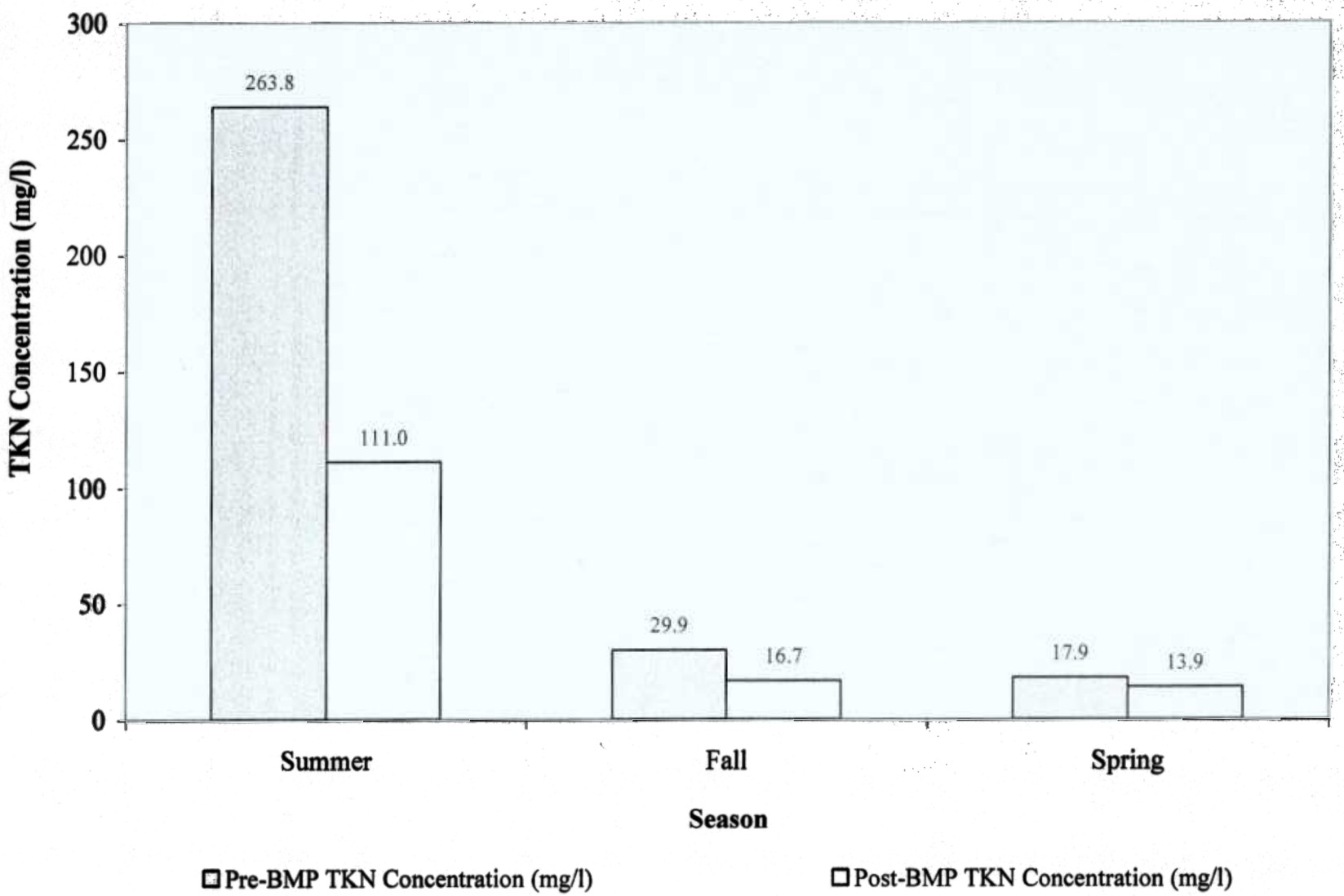
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre- and Post-BMP TSS Concentrations

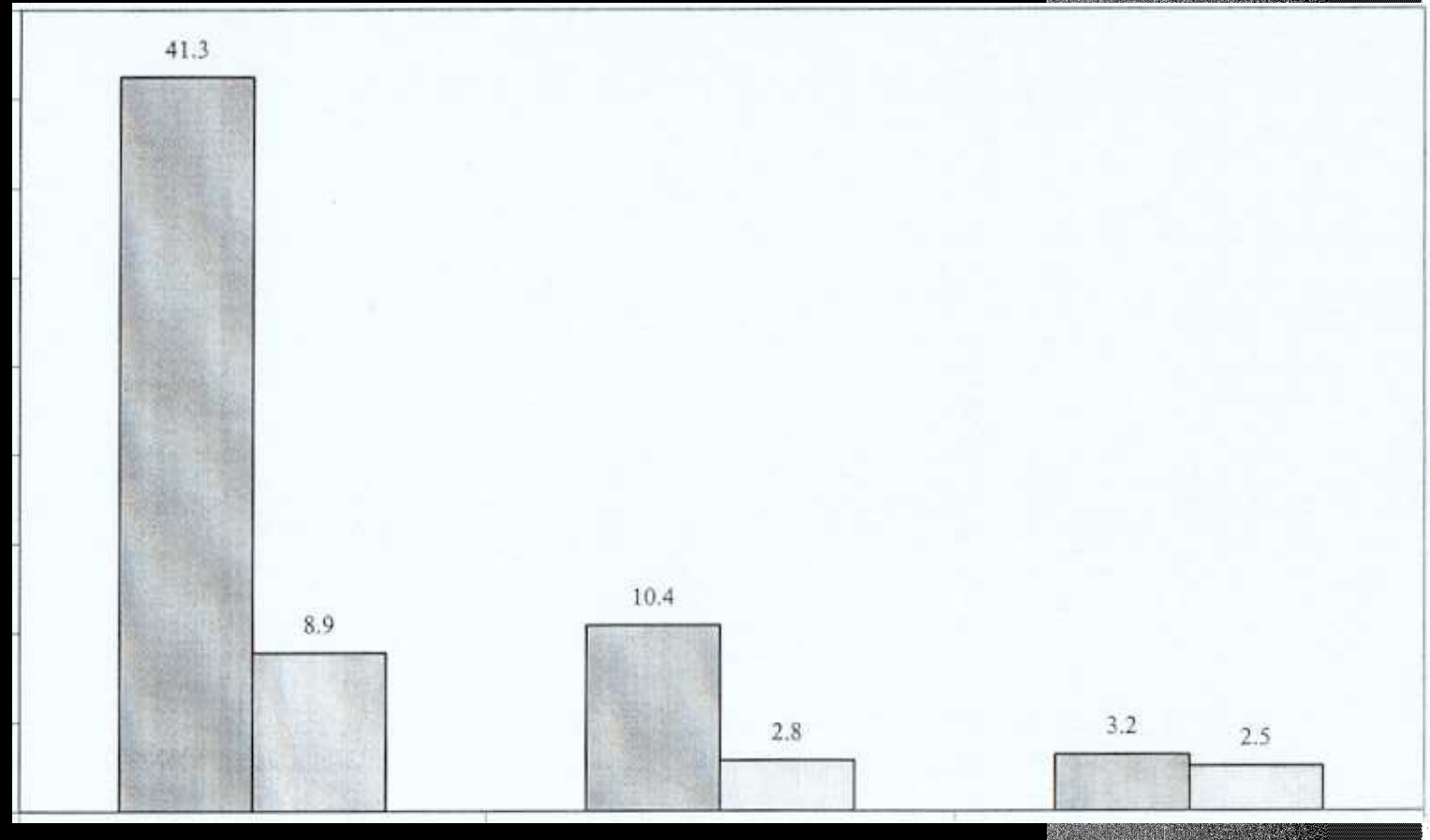
Figure 56



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre- and Post-BMP Total Kjeldhal Nitrogen (TKN) Concentrations

Figure 57



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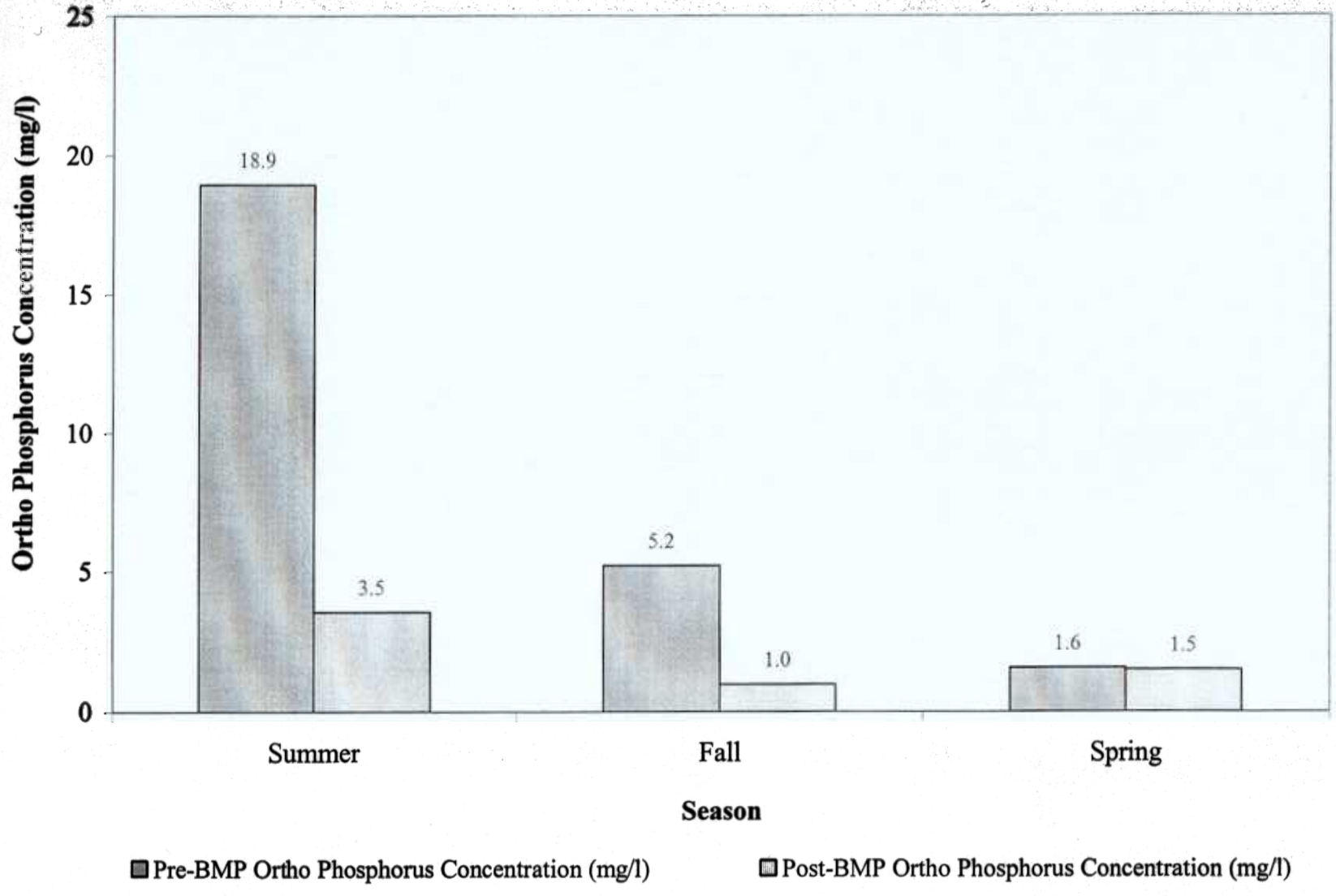
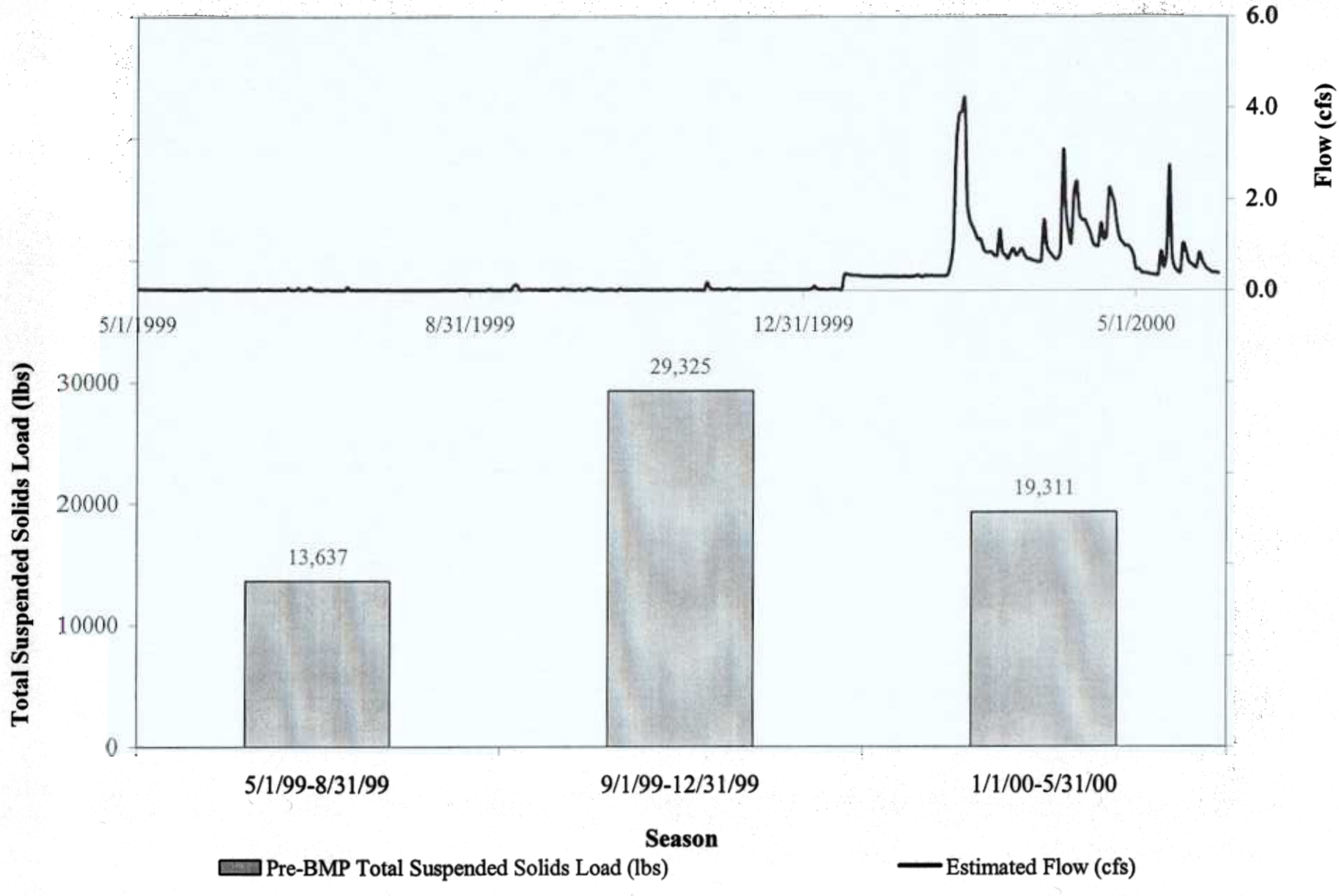


Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre- and Post-BMP Ortho-Phosphorus Concentrations

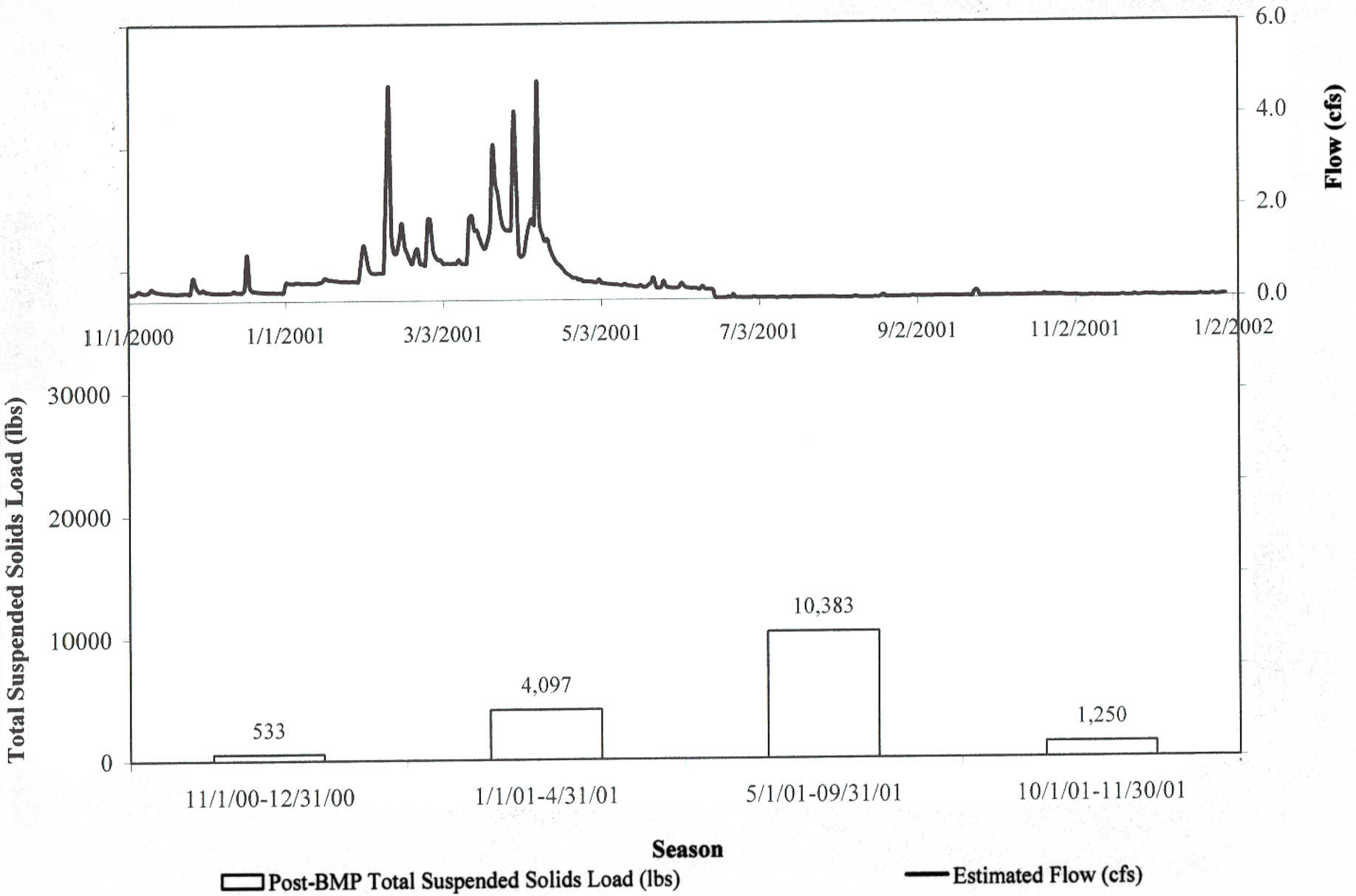
Figure 59



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph and TSS Loading

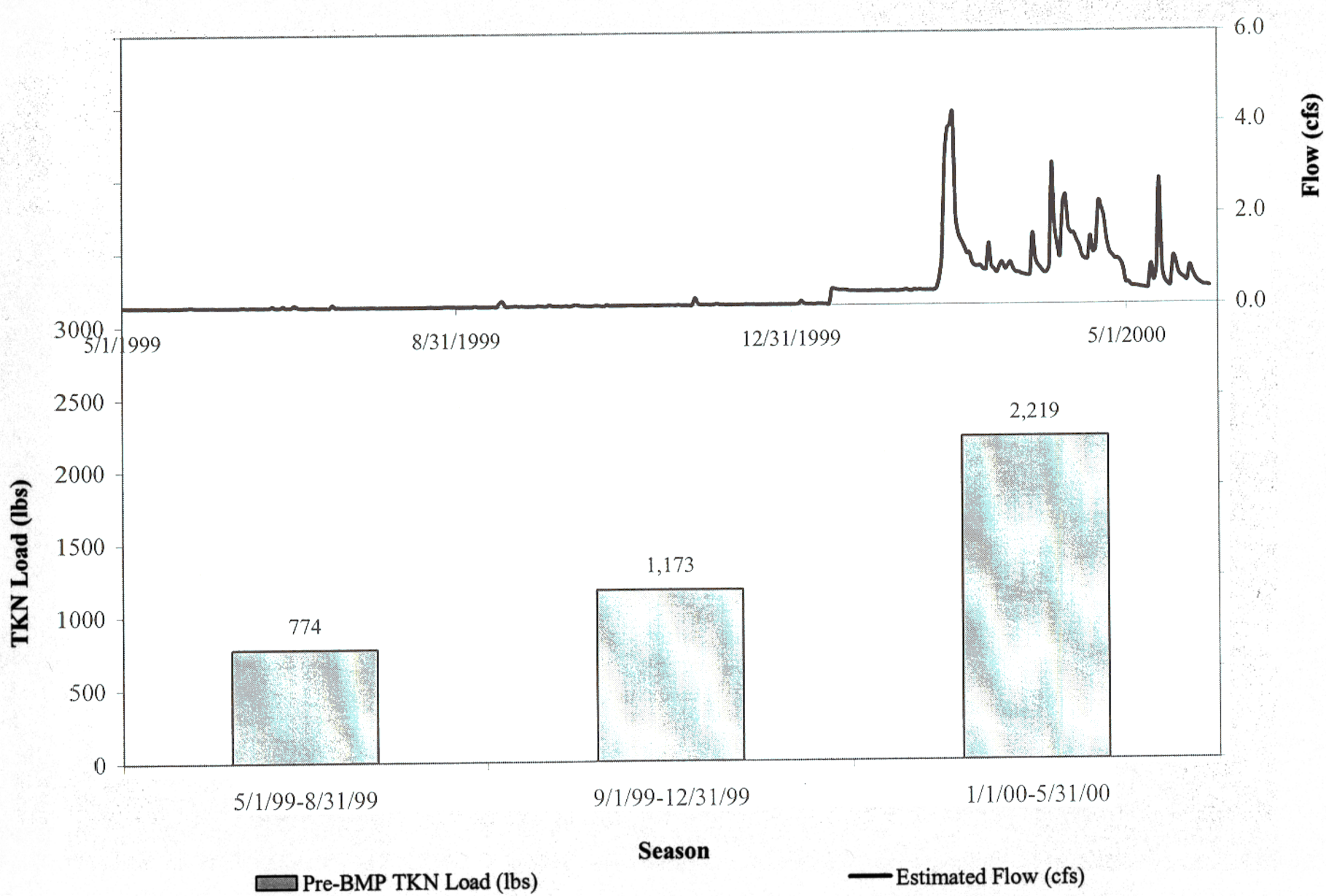
Figure 60



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph and TSS Loading

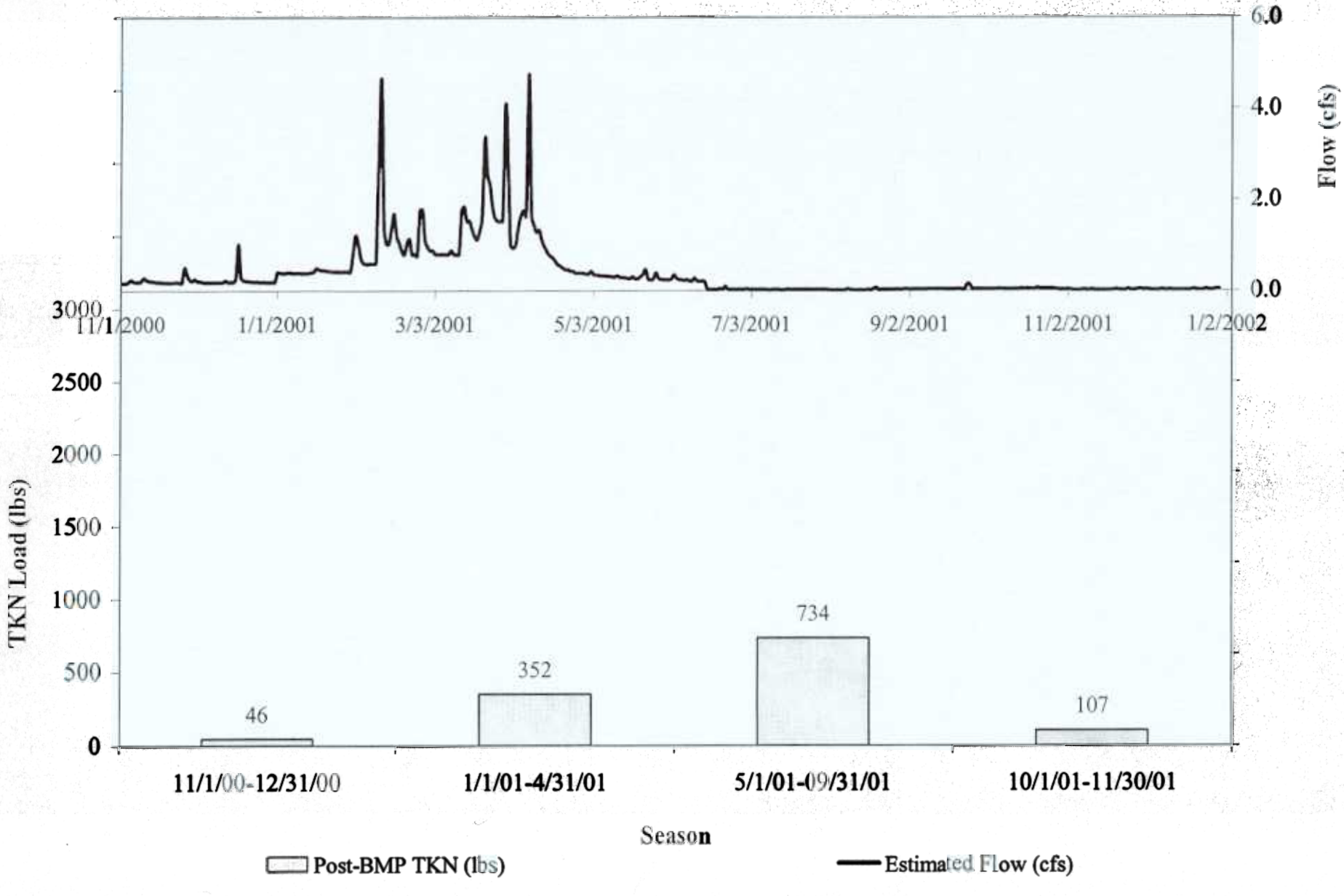
Figure 61



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

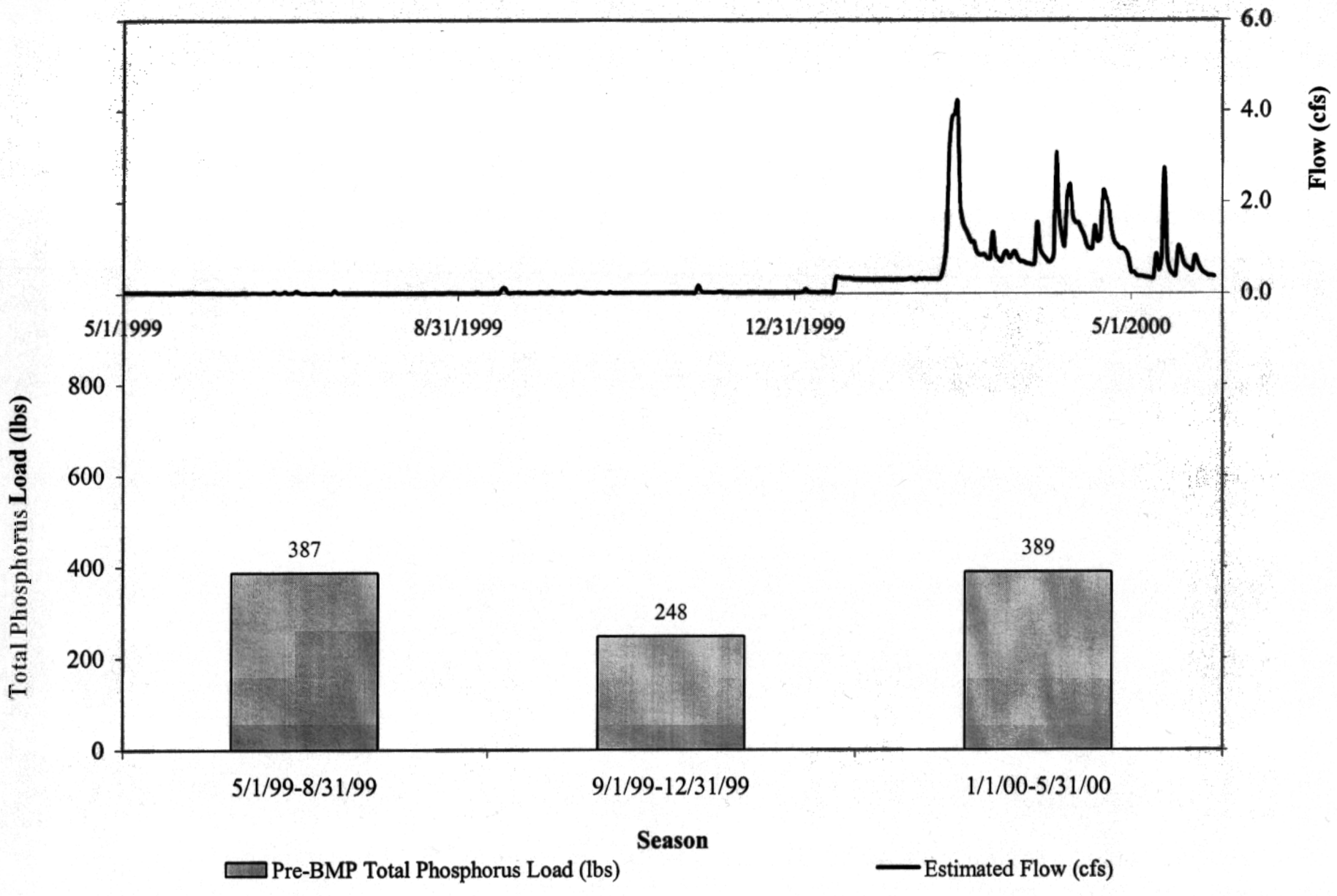
Figure 62



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

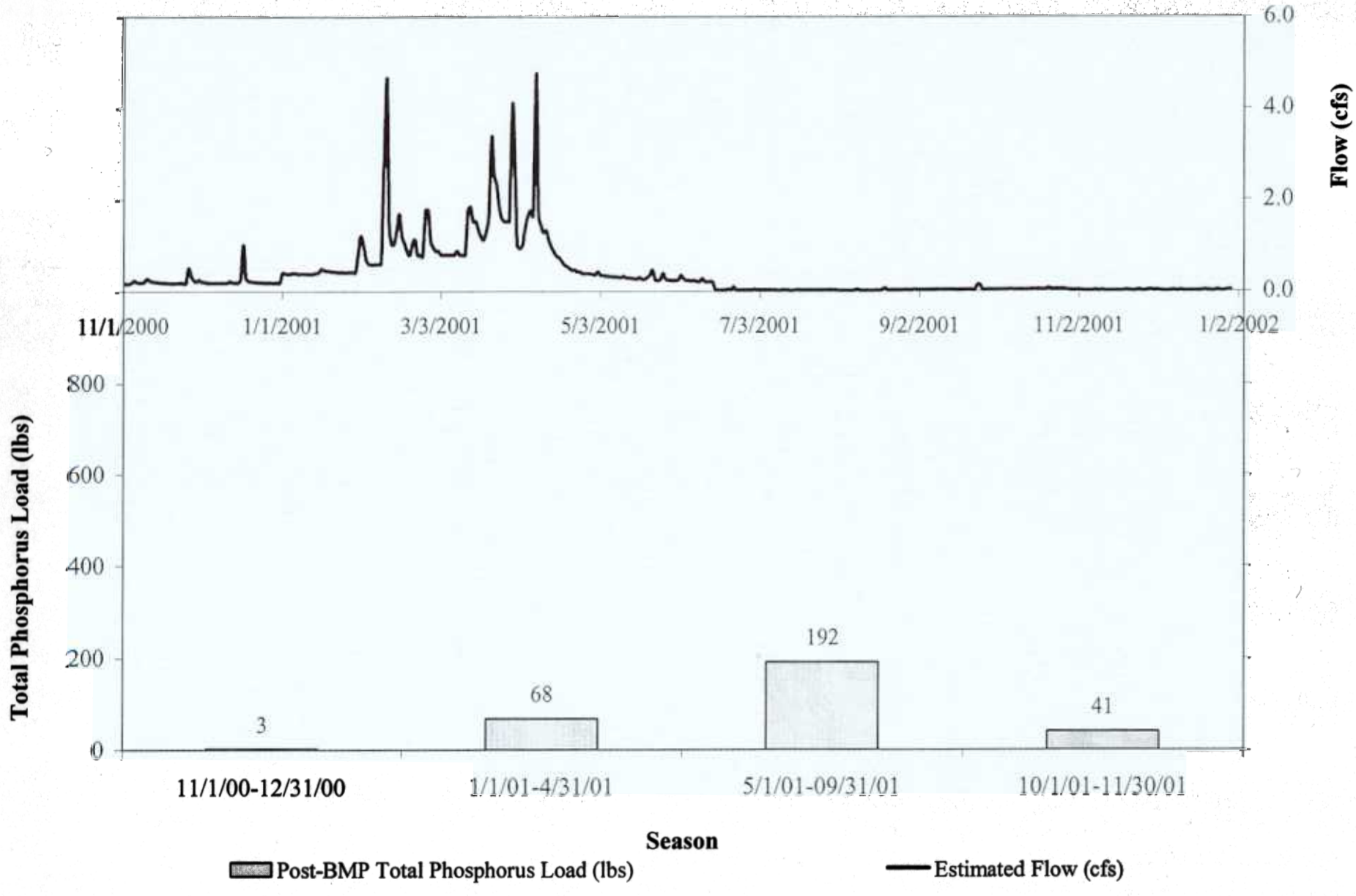
Figure 63



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph and Total Phosphorus Loading

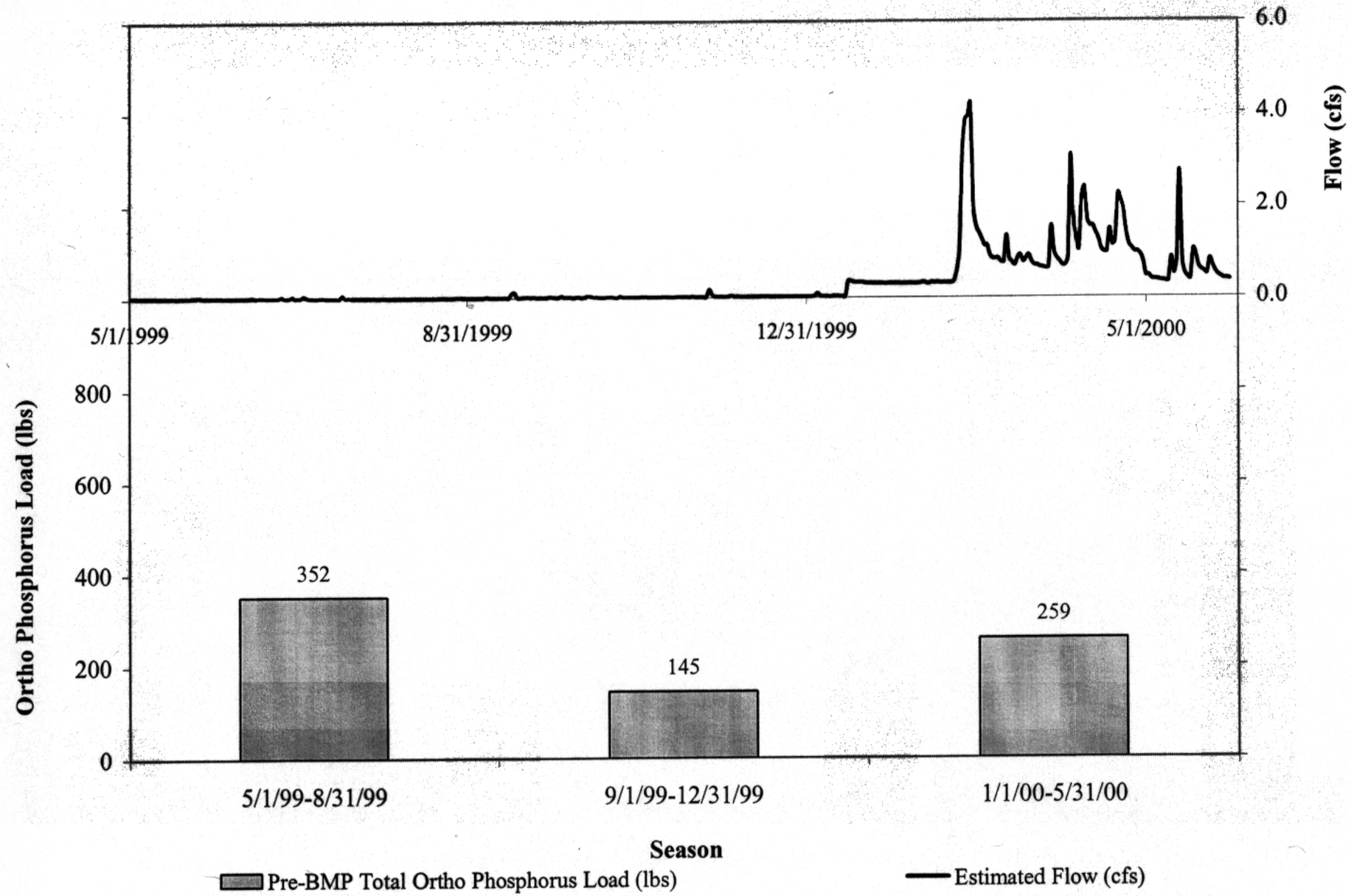
Figure 64



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph and Total Phosphorus Loading

Figure 65



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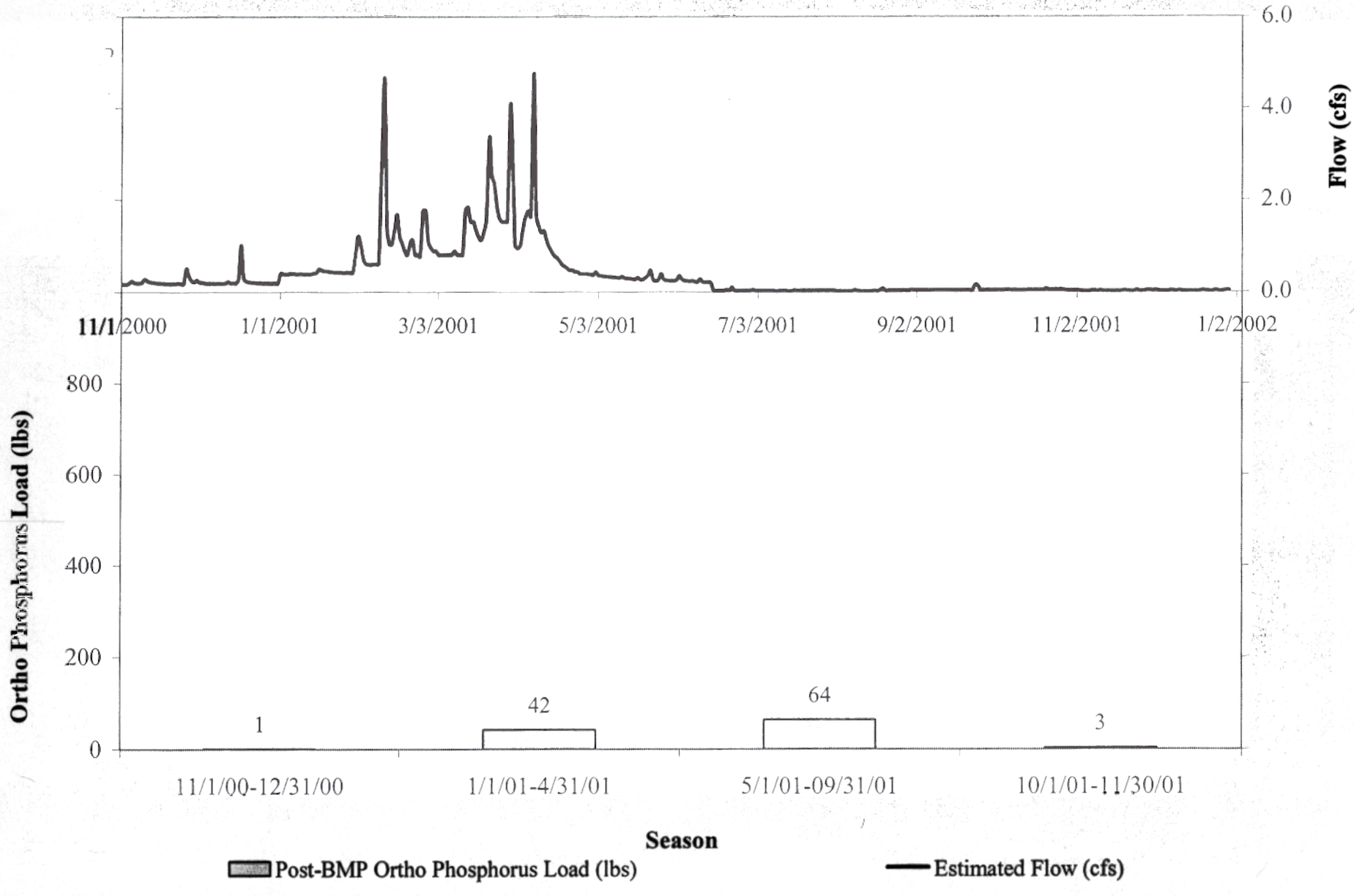
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph andOrtho-Phosphorus Loading

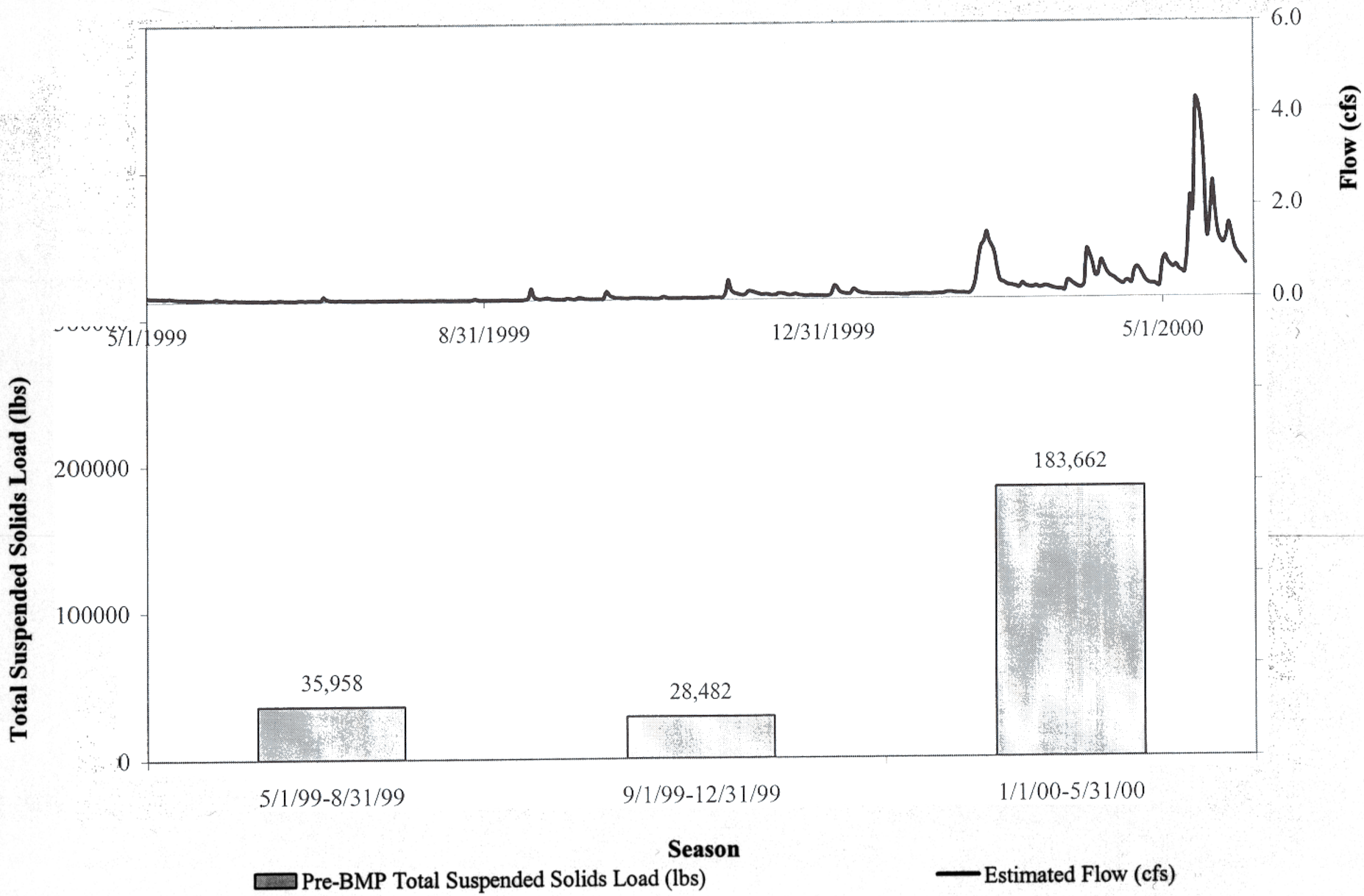
Figure 66



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph andOrtho-Phosphorus Loading

Figure 67



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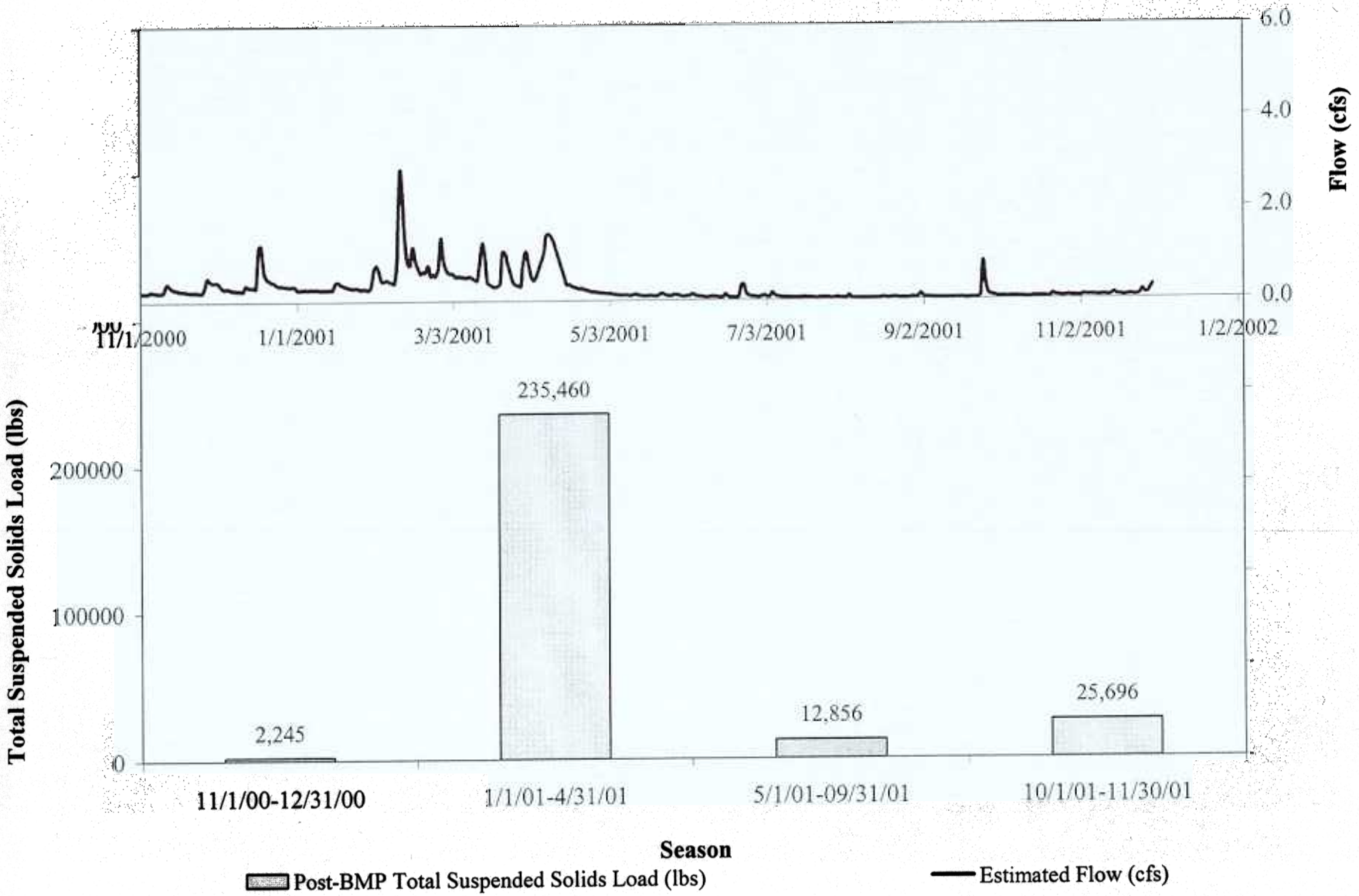
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph and TSS Loading

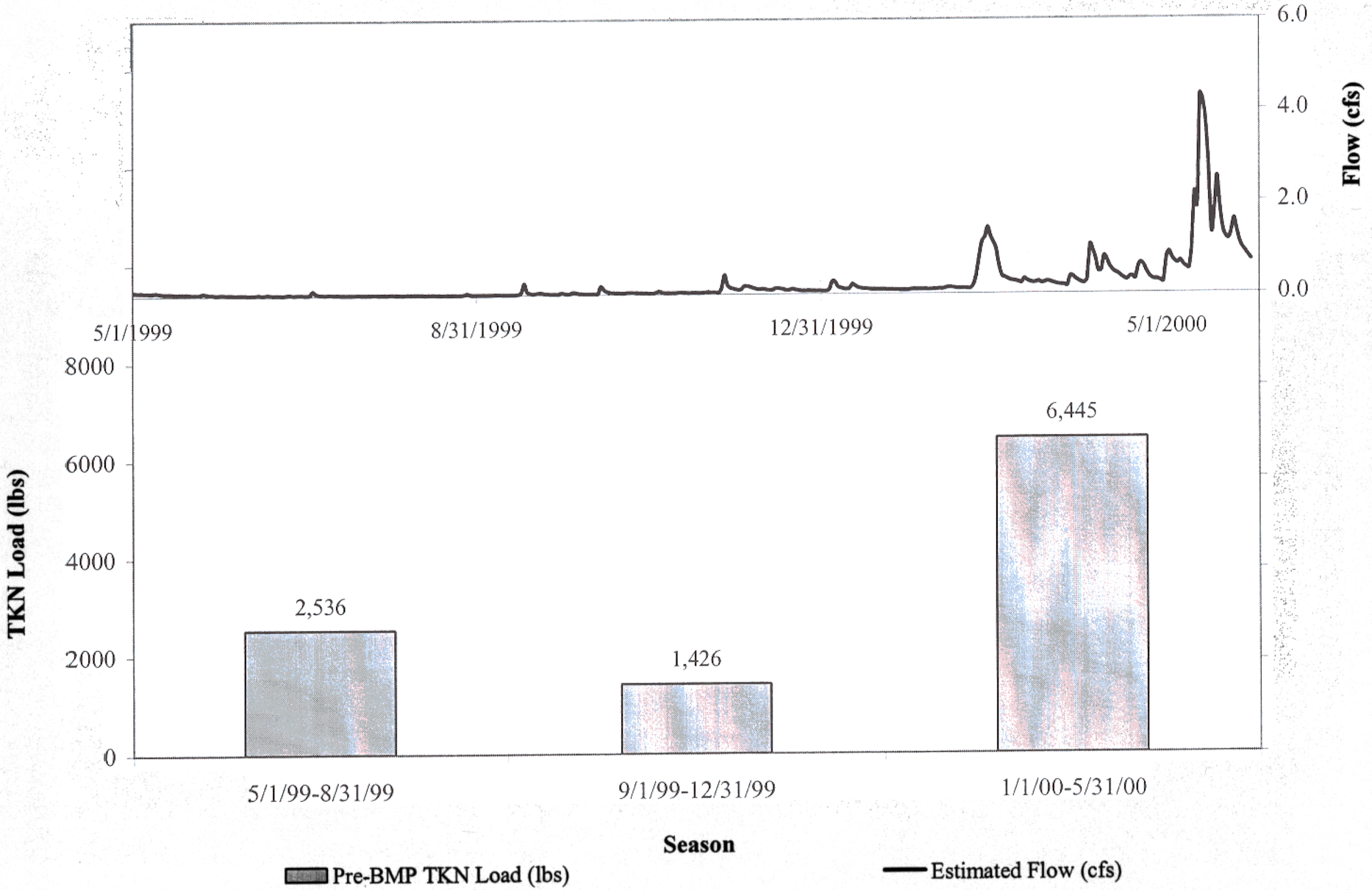
Figure 68



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph and TSS Loading

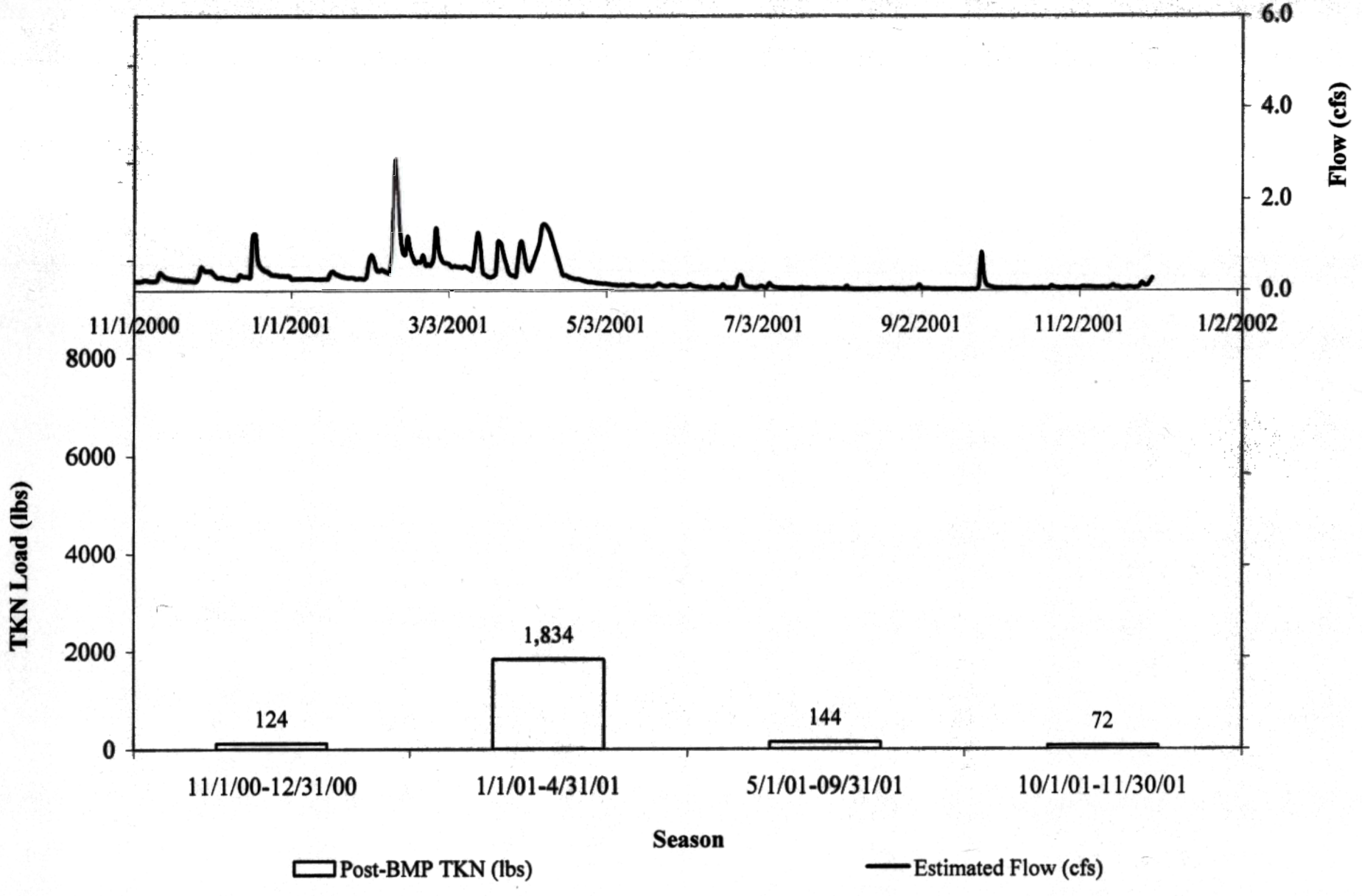
Figure 69



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

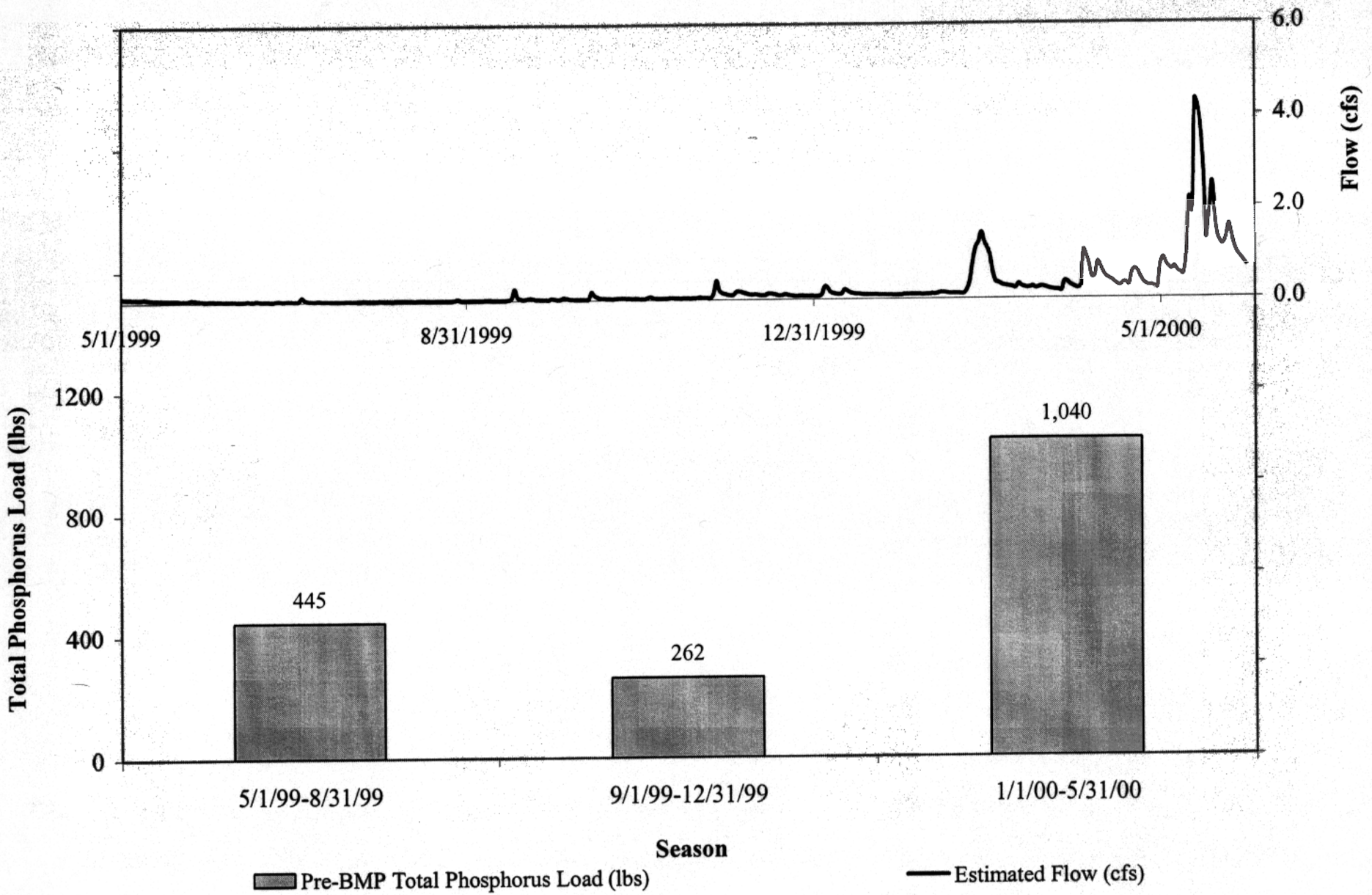
Figure 70



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

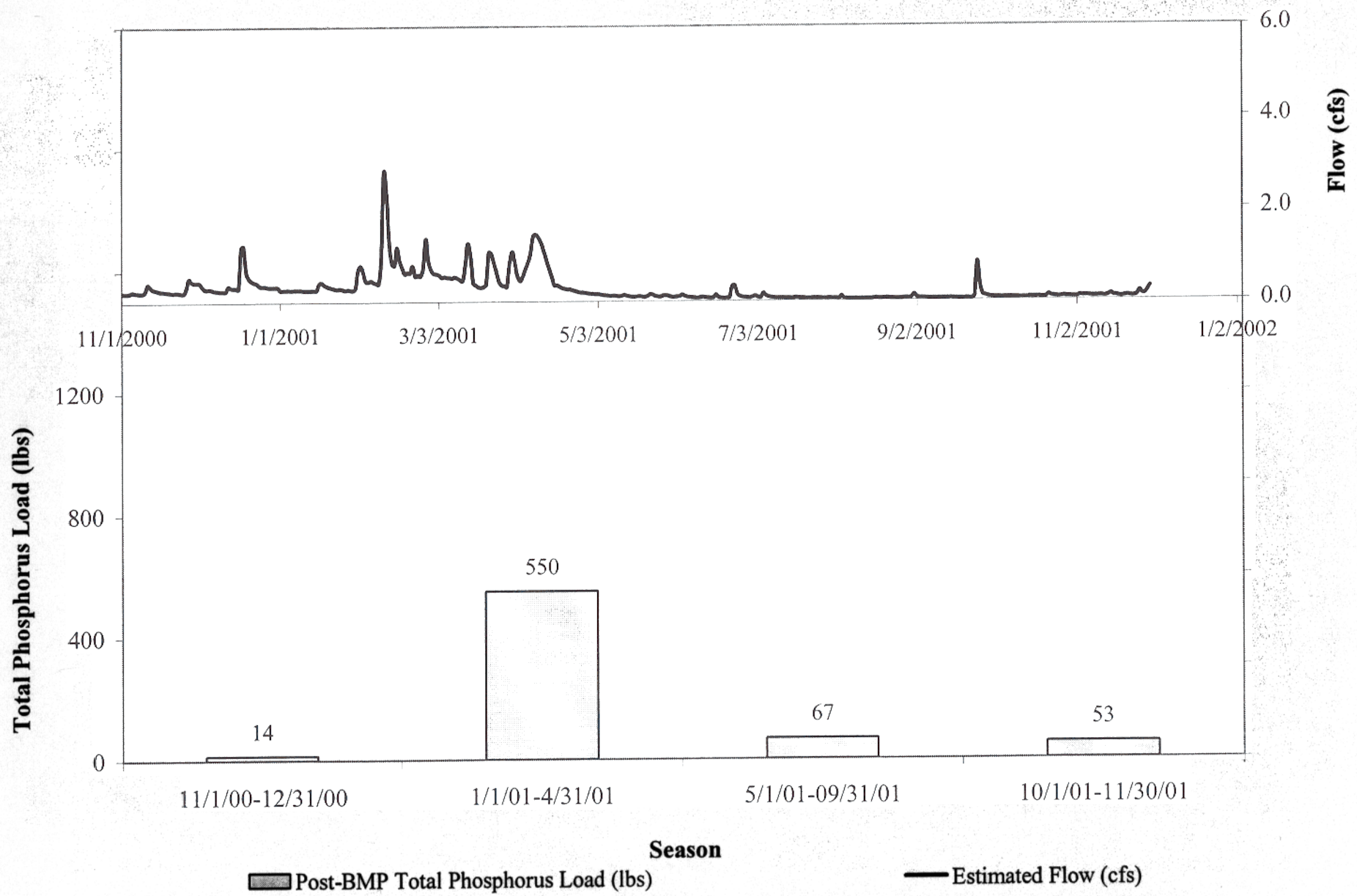
Figure 71



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph and Total Phosphorus Loading

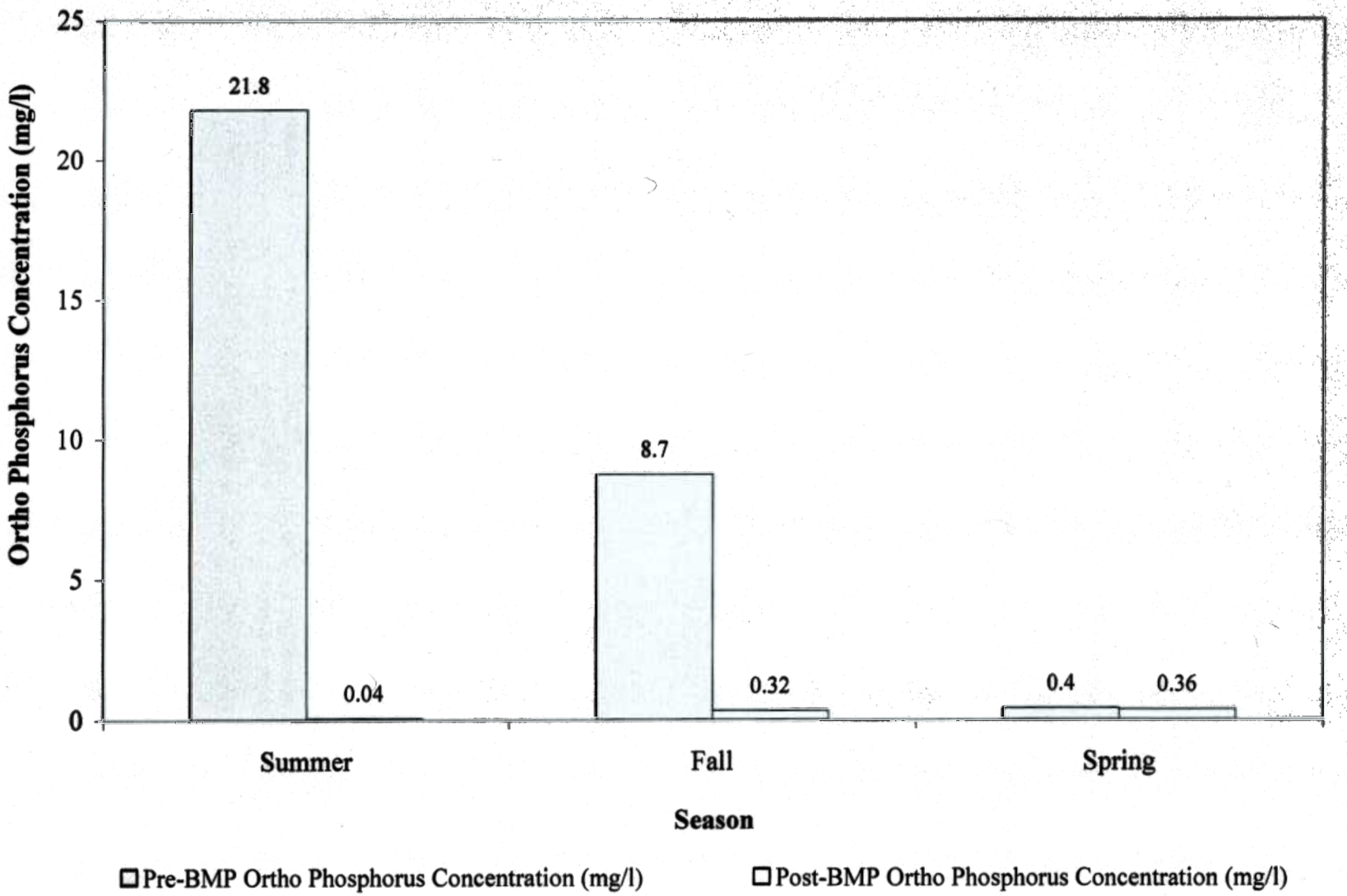
Figure 72



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph and Total Phosphorus Loading

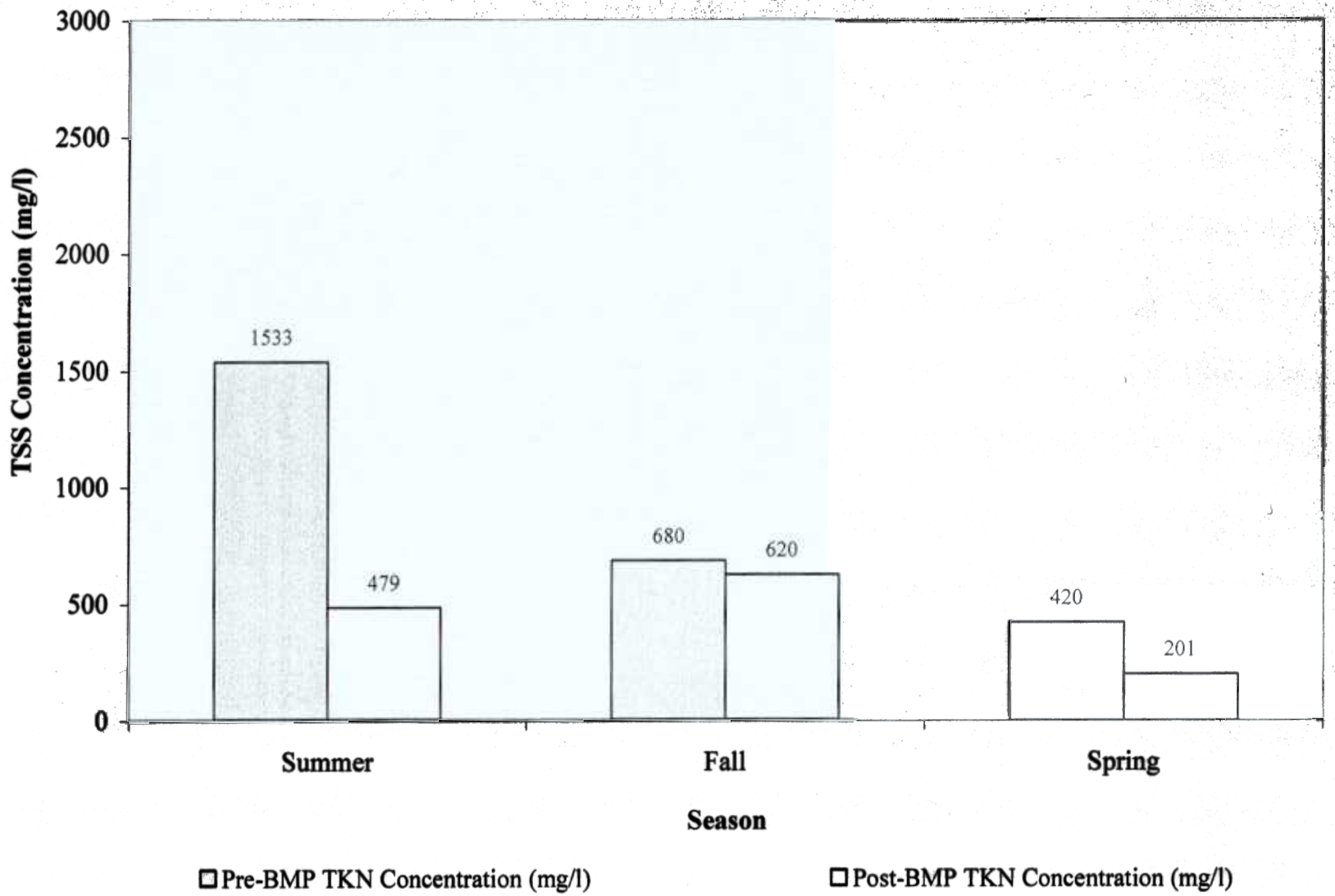
Figure 73



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre- and Post-BMP Ortho-Phosphorus Concentrations

Figure 51



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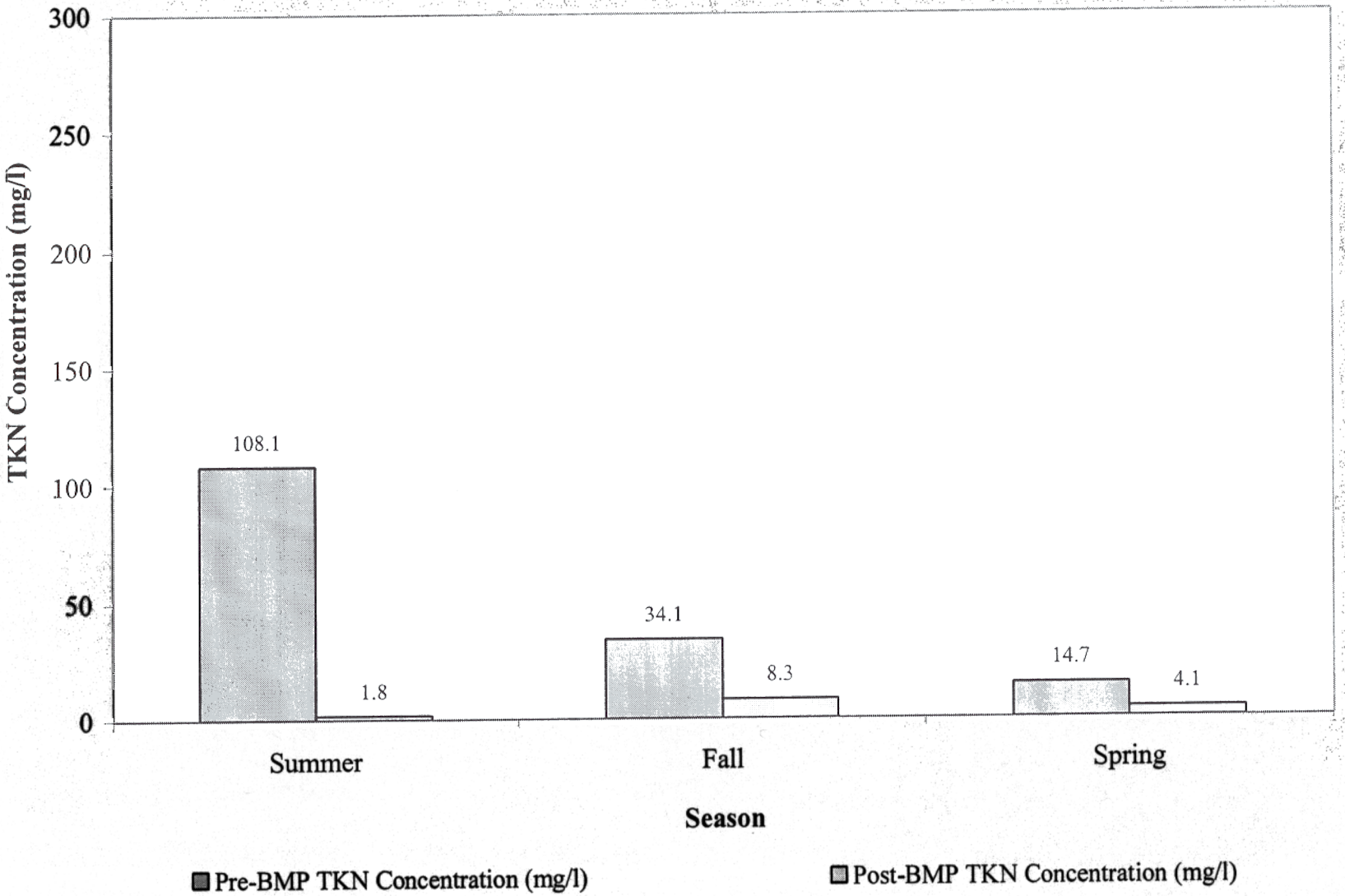
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP TSS Concentrations

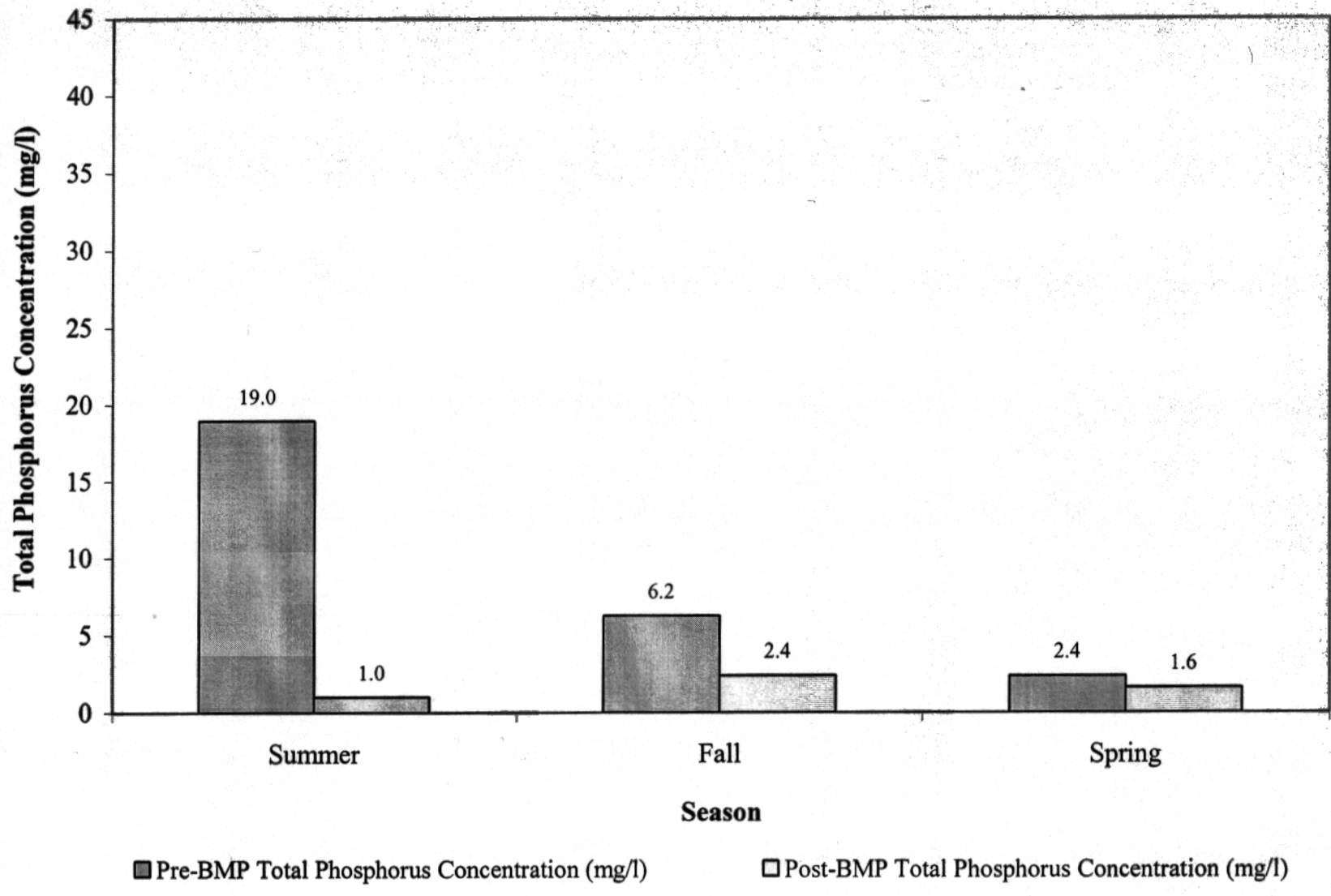
Figure 52



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP Total Kjeldhal Nitrogen (TKN) Concentrations

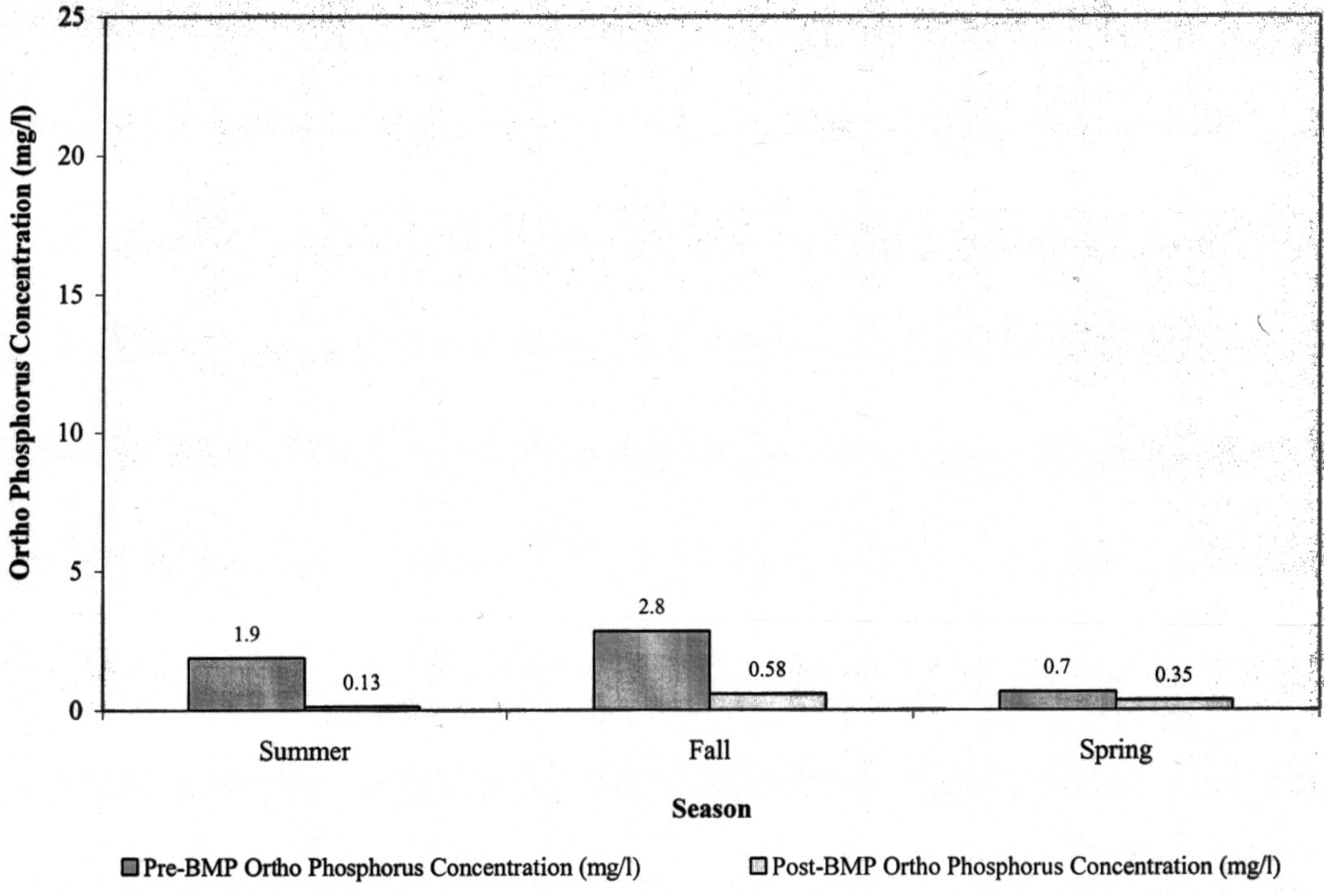
Figure 53



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP Total Phosphorus Concentrations

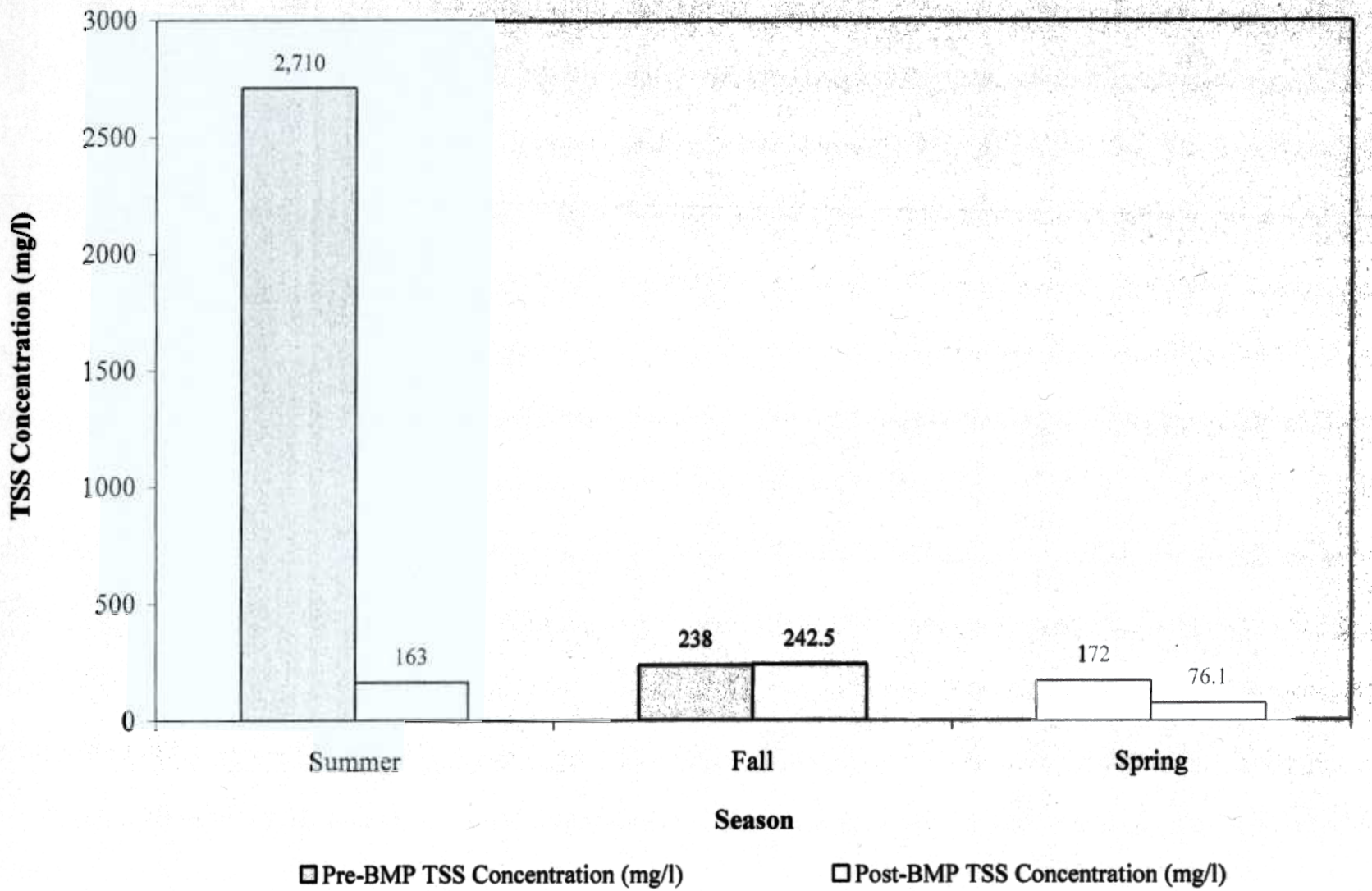
Figure 54



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre- and Post-BMP Ortho-Phosphorus Concentrations

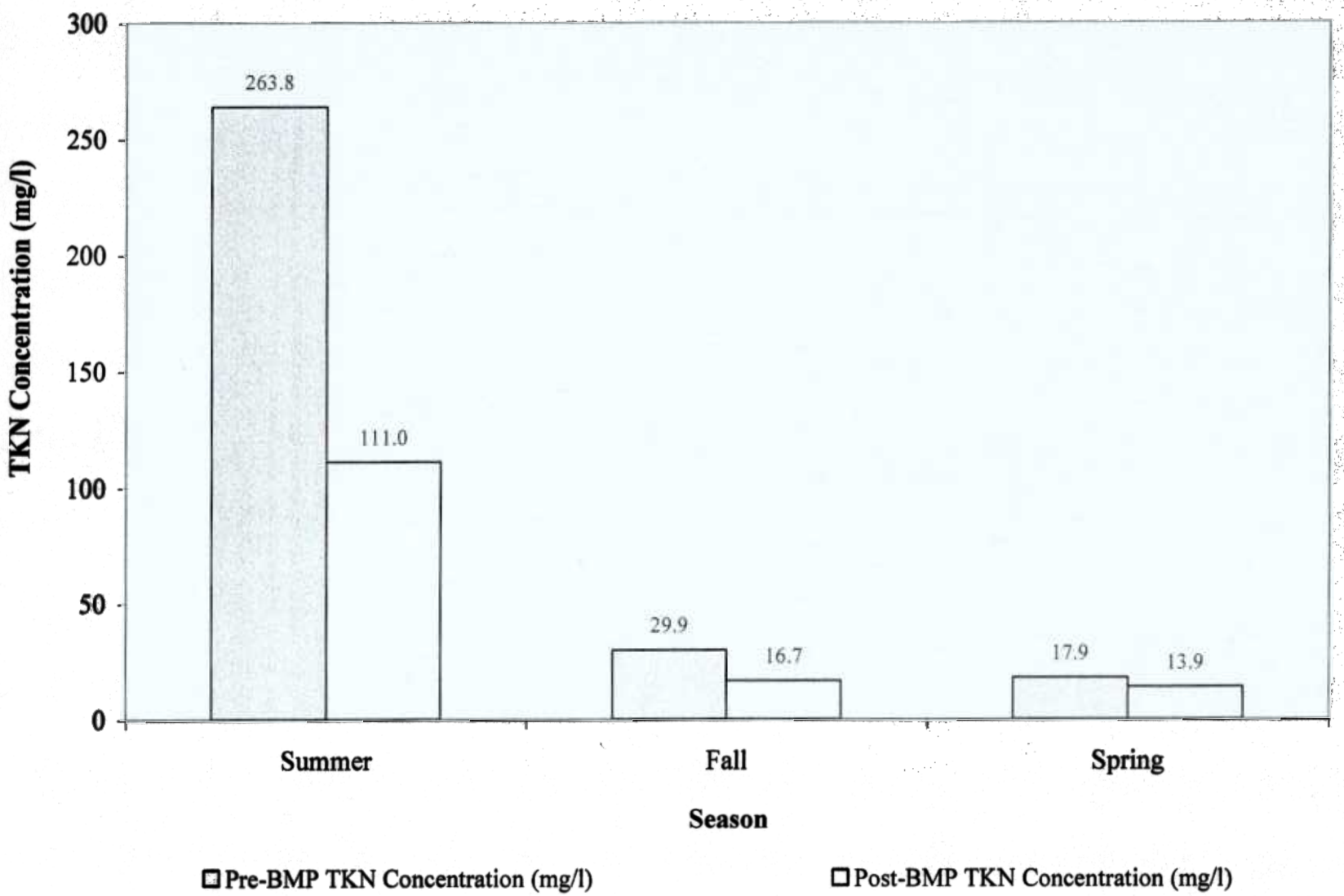
Figure 55



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre- and Post-BMP TSS Concentrations

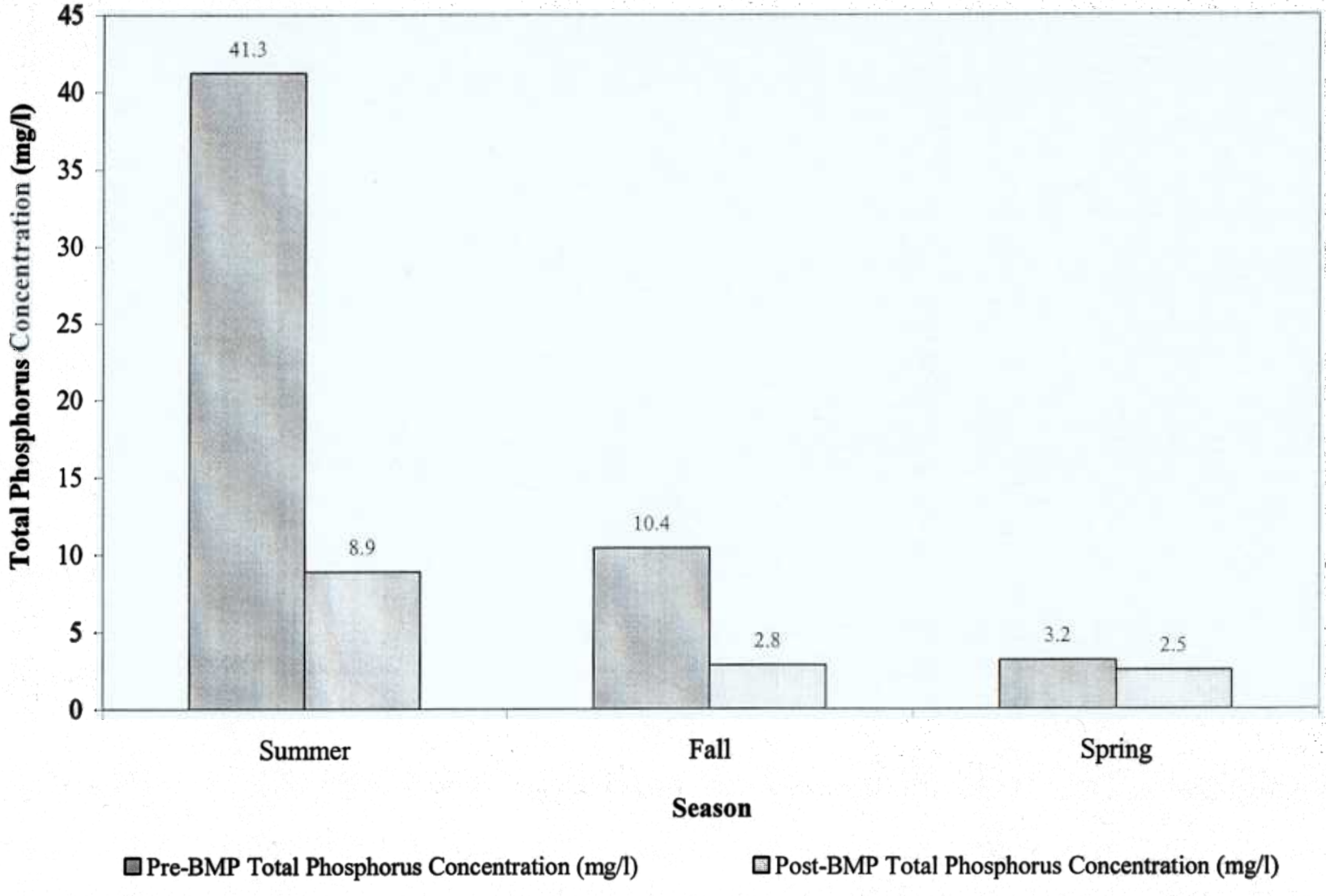
Figure 56



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre- and Post-BMP Total Kjeldhal Nitrogen (TKN) Concentrations

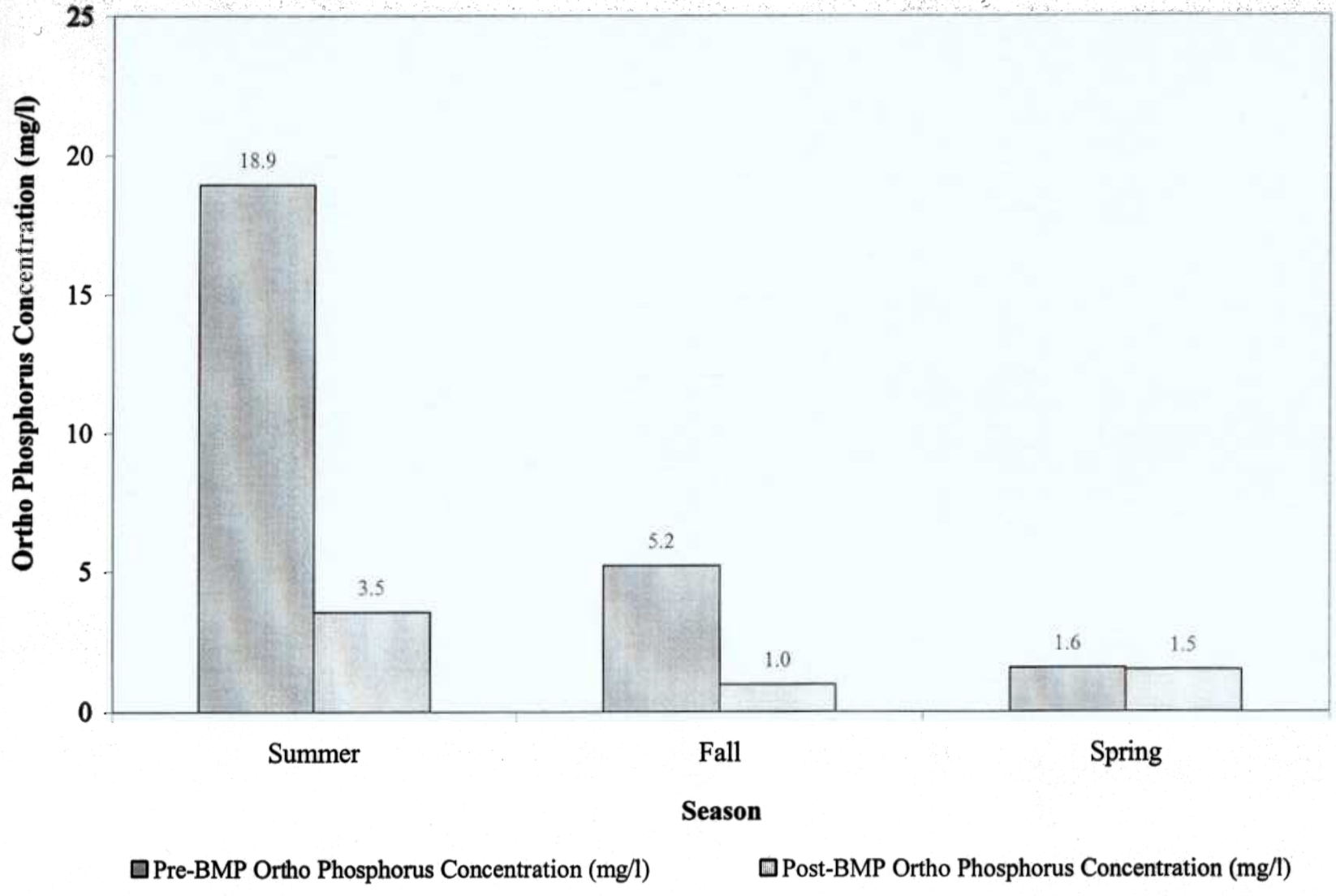
Figure 57



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre- and Post-BMP Total Phosphorus Concentrations

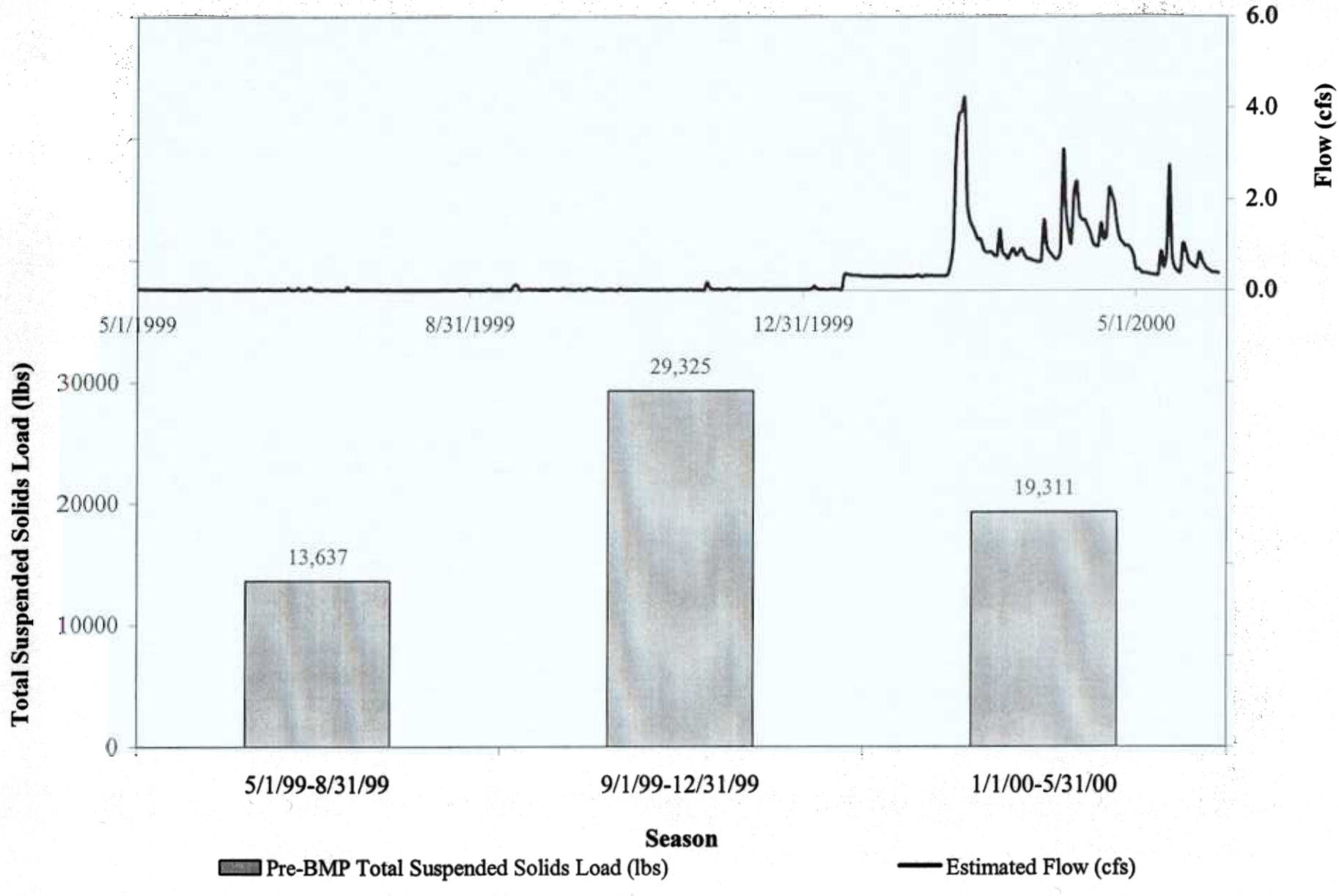
Figure 58



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre- and Post-BMP Ortho-Phosphorus Concentrations

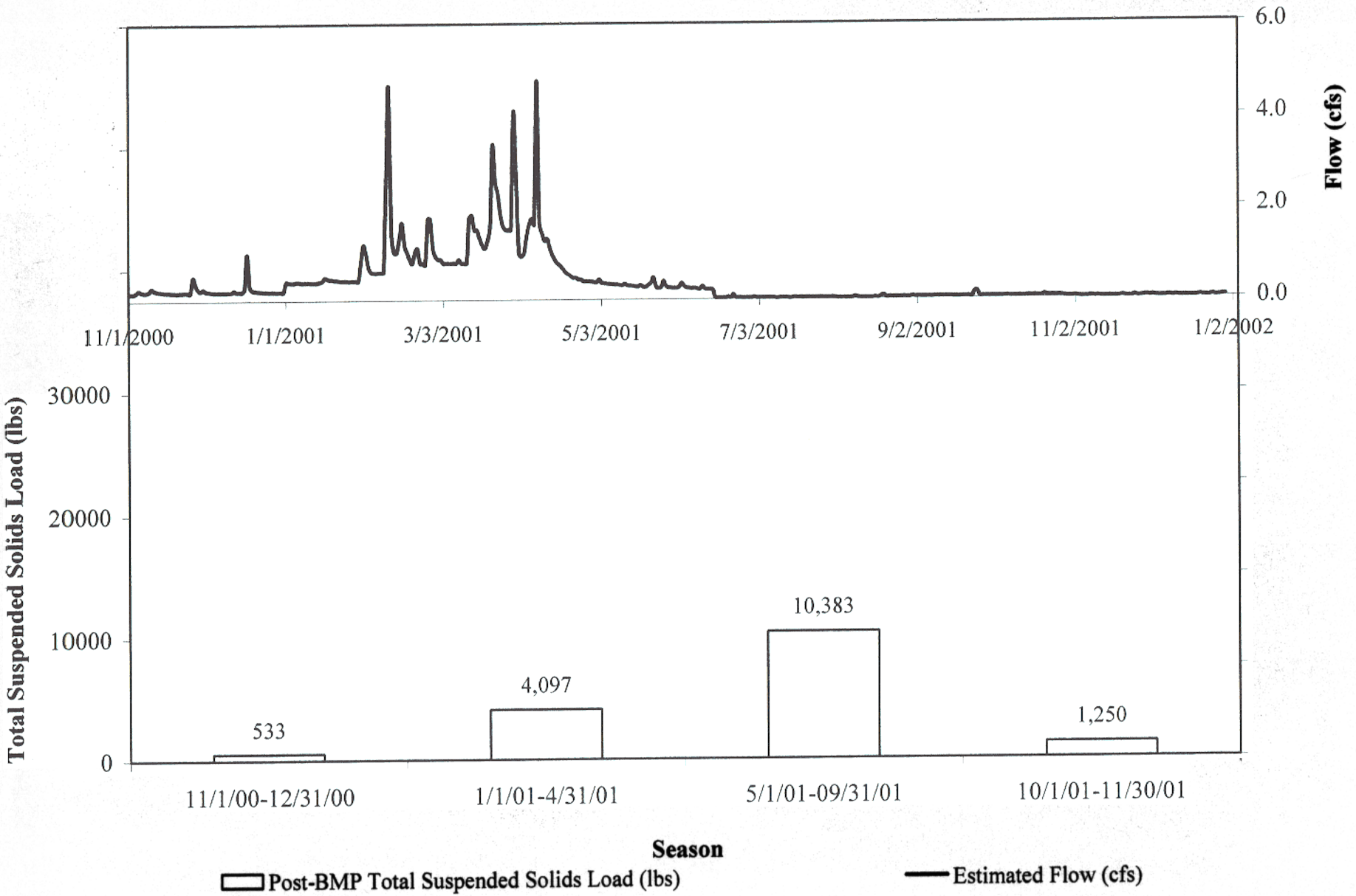
Figure 59



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph and TSS Loading

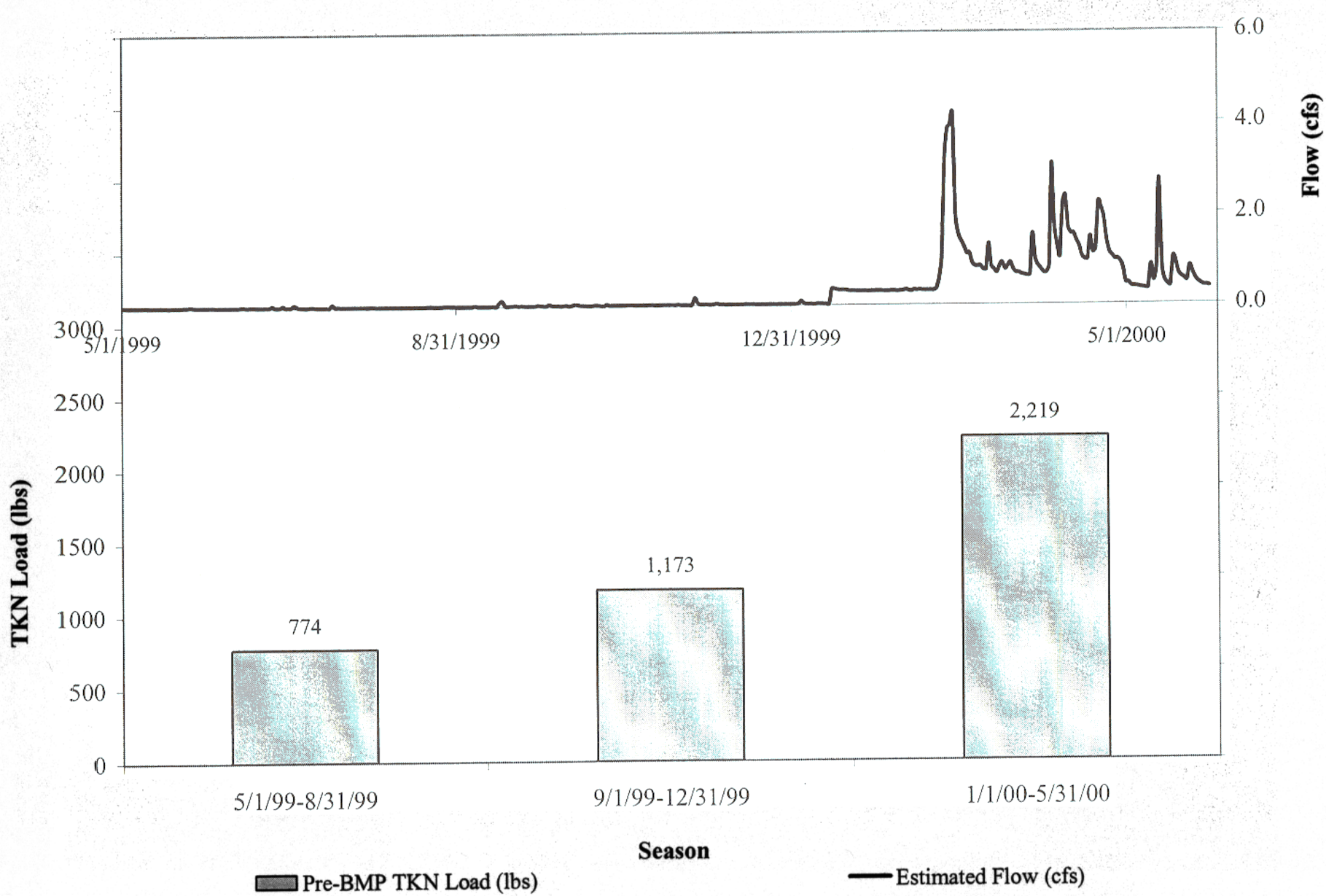
Figure 60



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph and TSS Loading

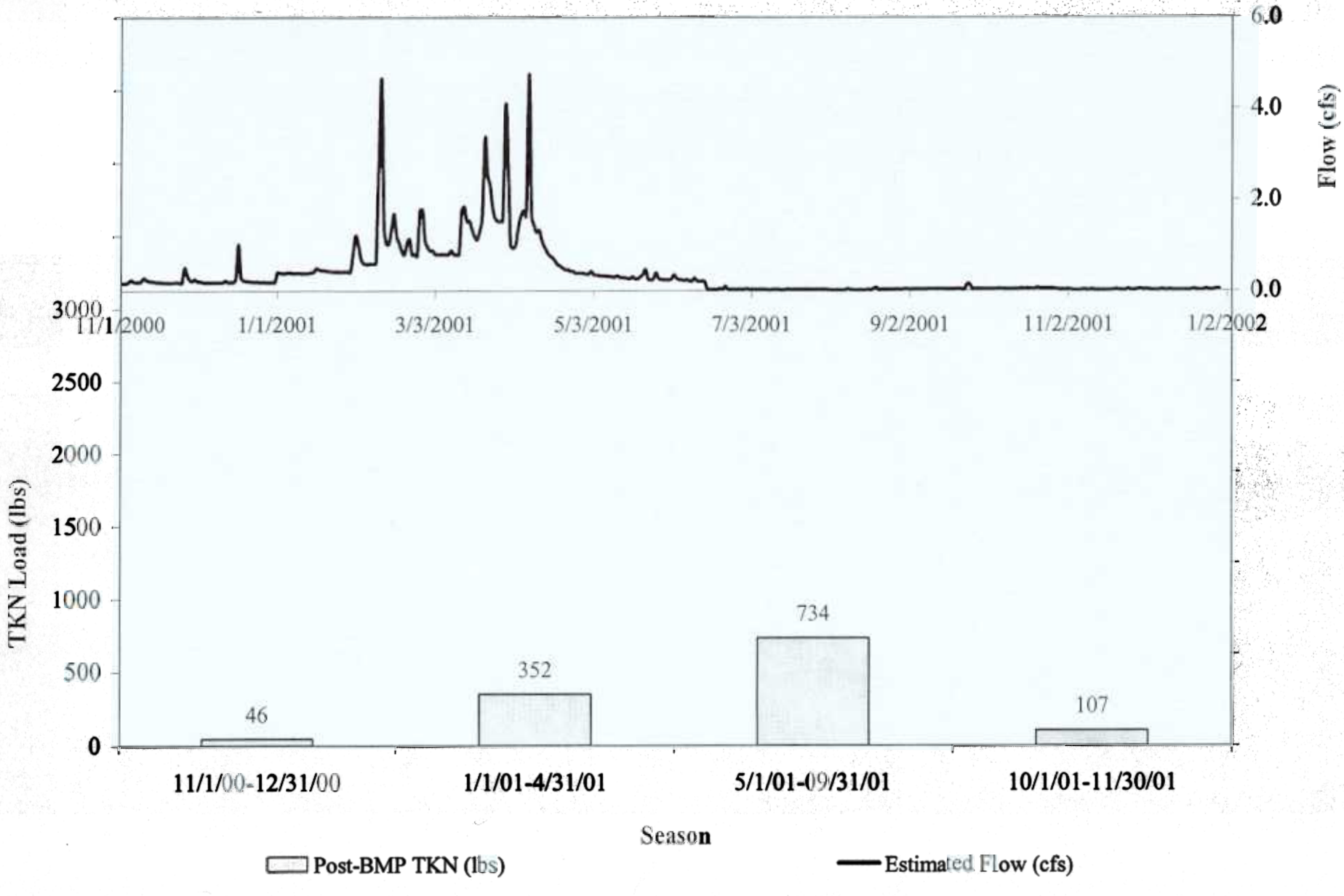
Figure 61



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

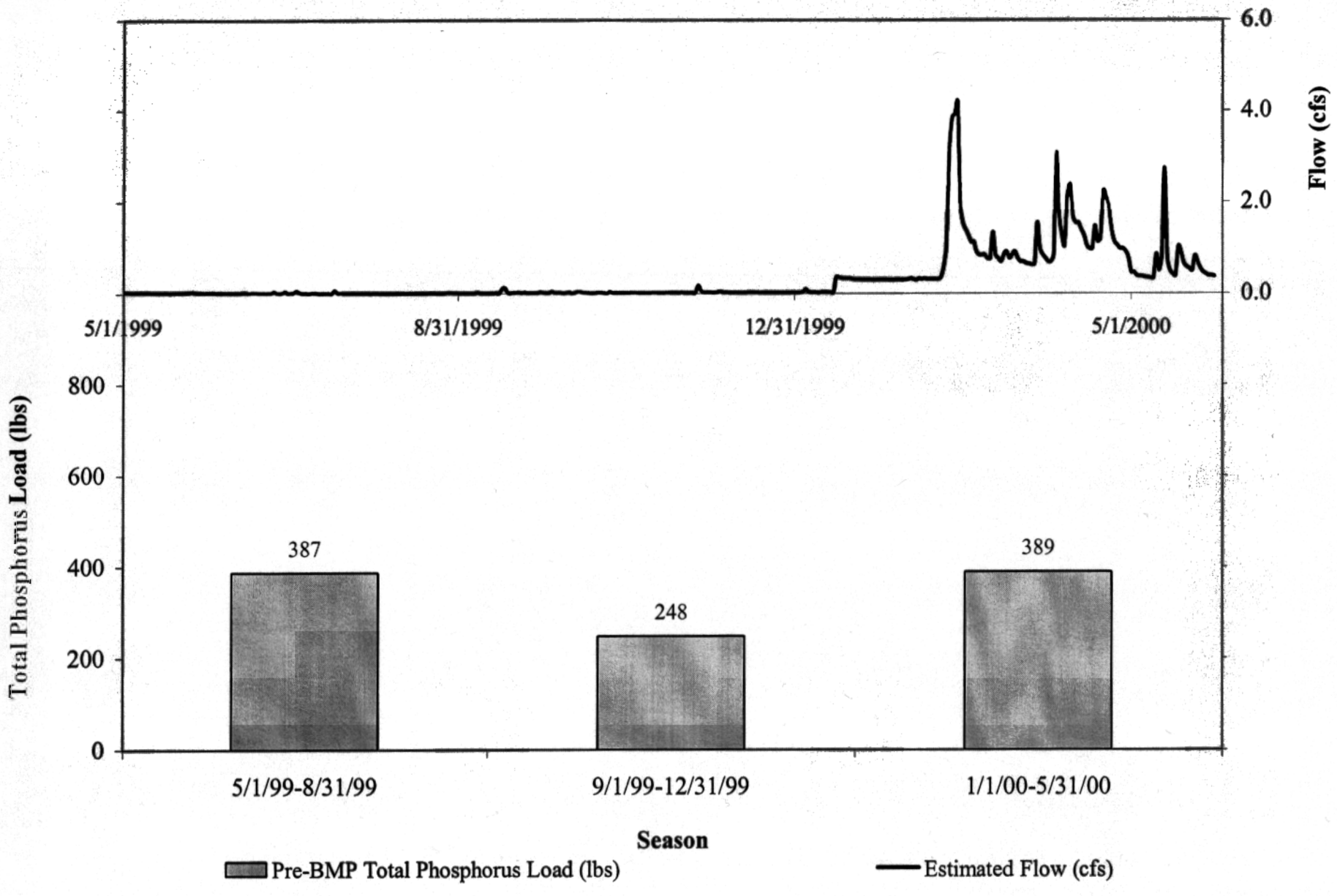
Figure 62



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

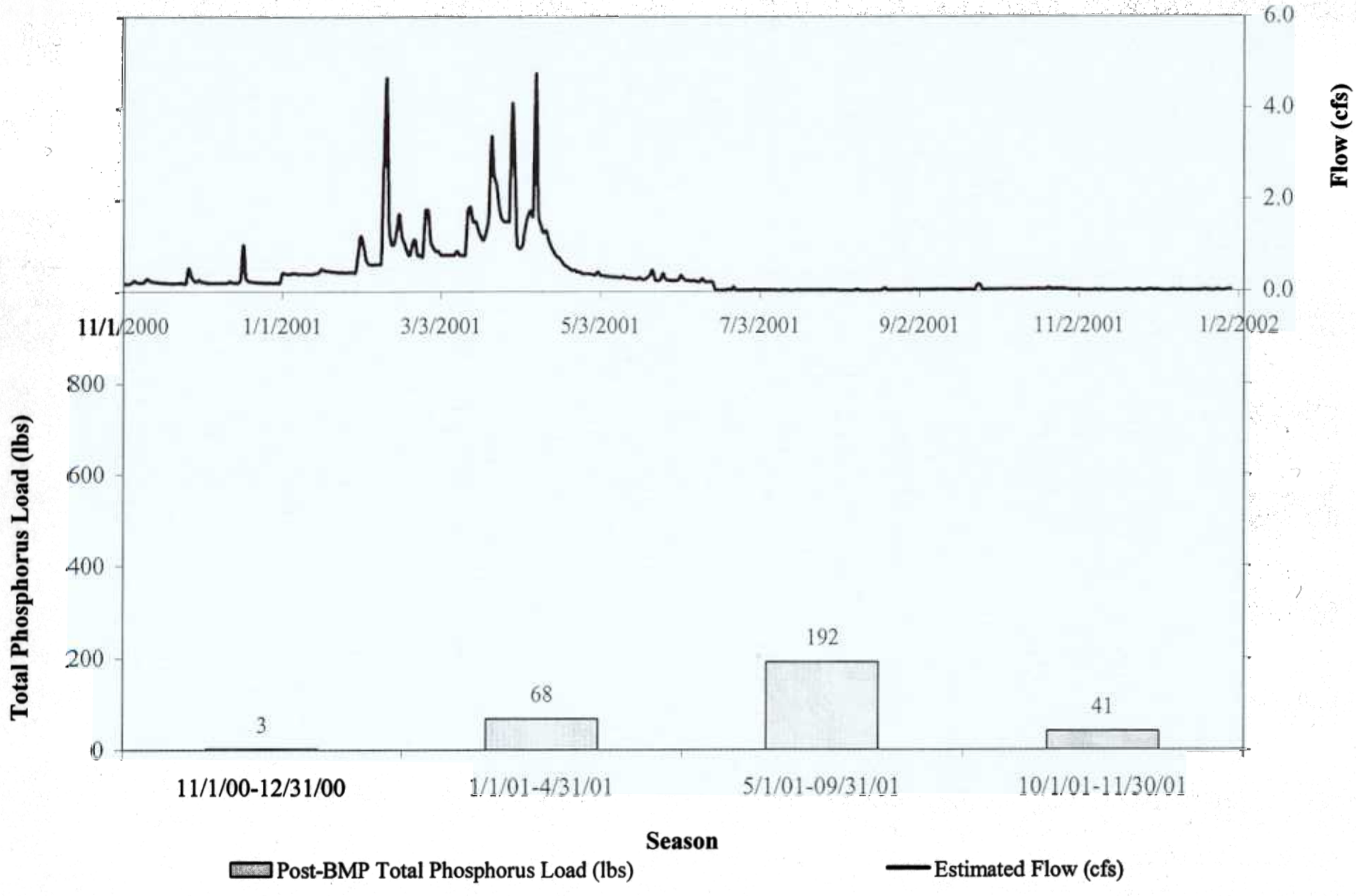
Figure 63



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph and Total Phosphorus Loading

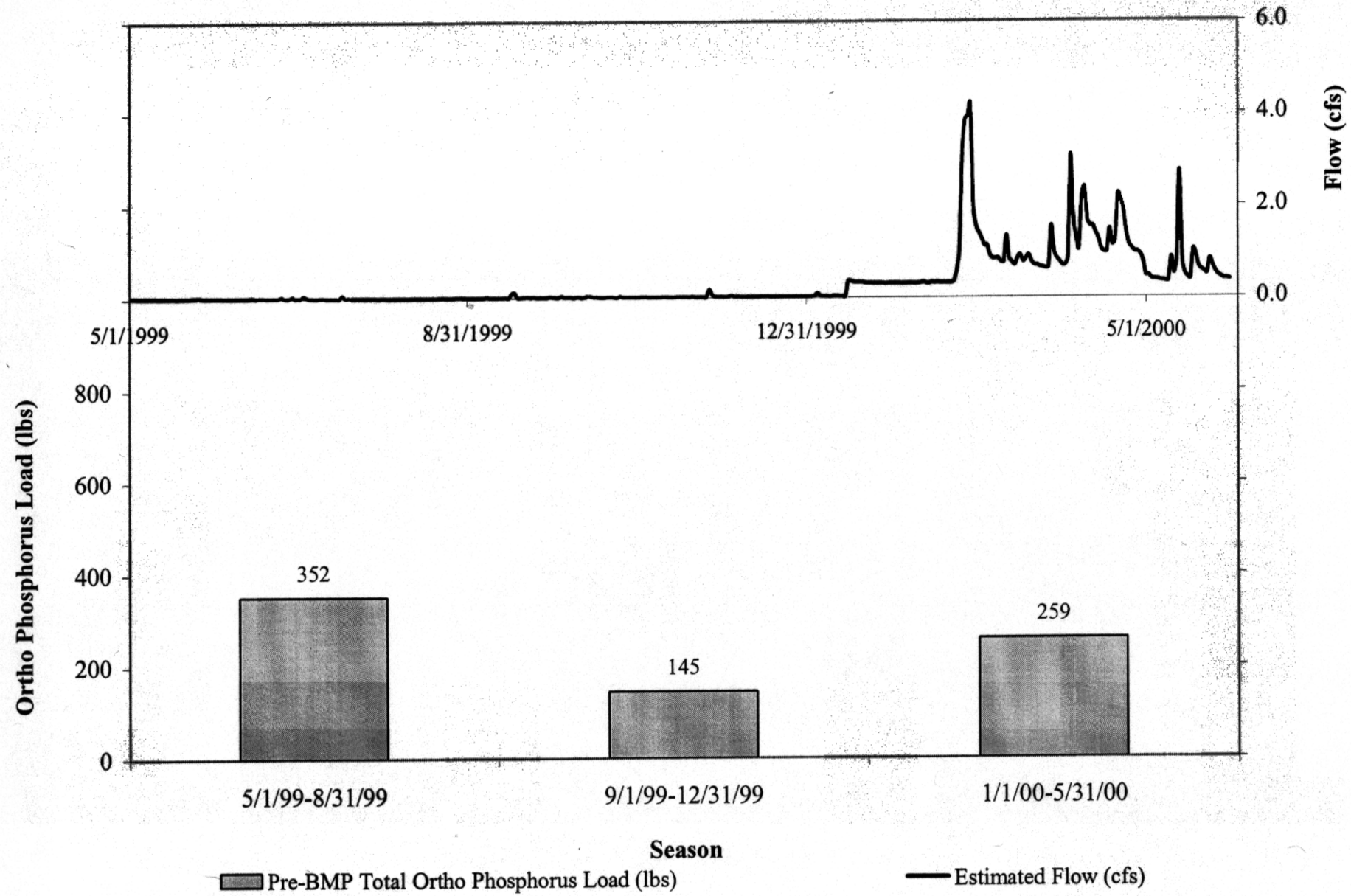
Figure 64



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph and Total Phosphorus Loading

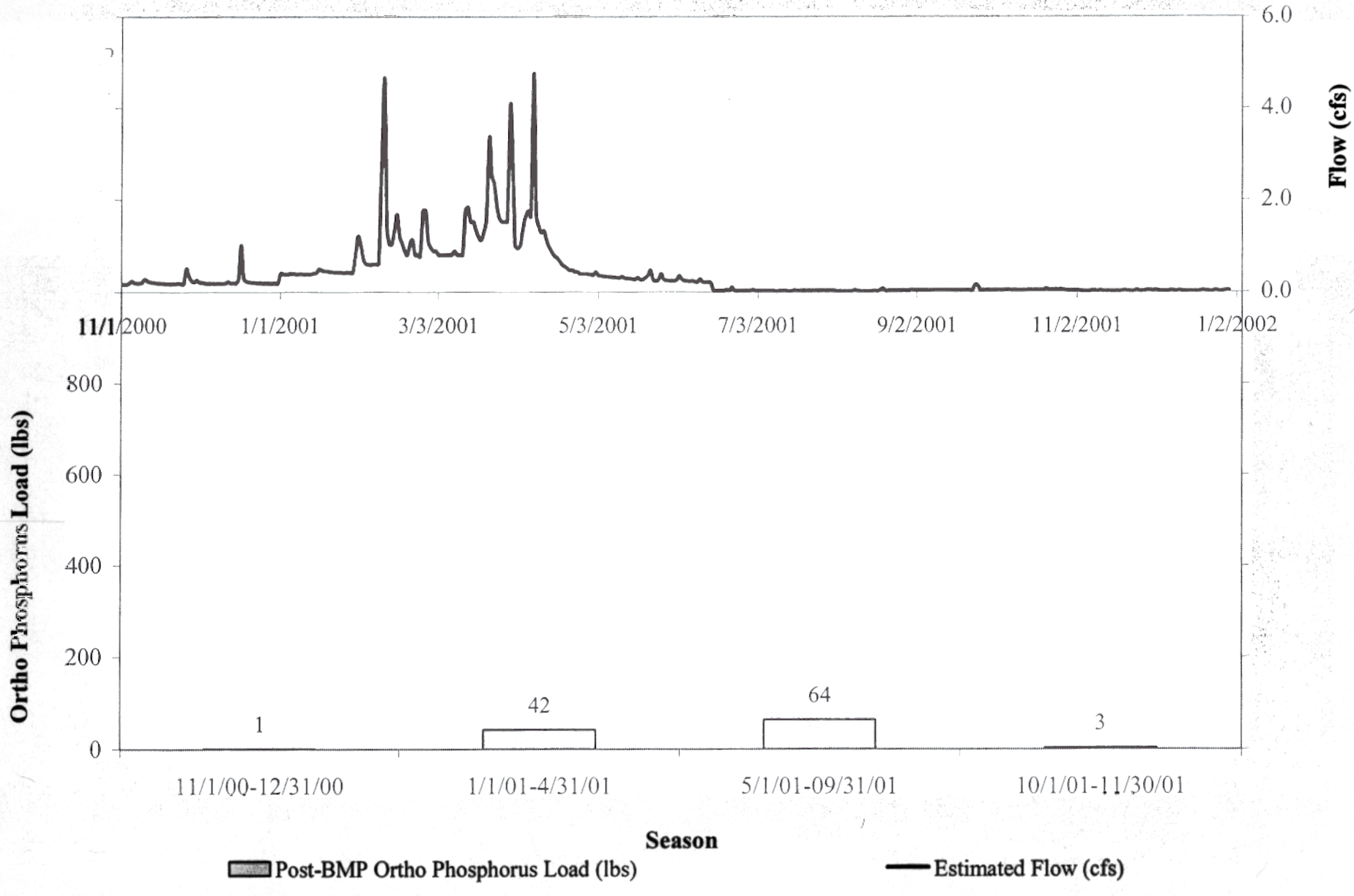
Figure 65



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Pre-BMP Hydrograph andOrtho-Phosphorus Loading

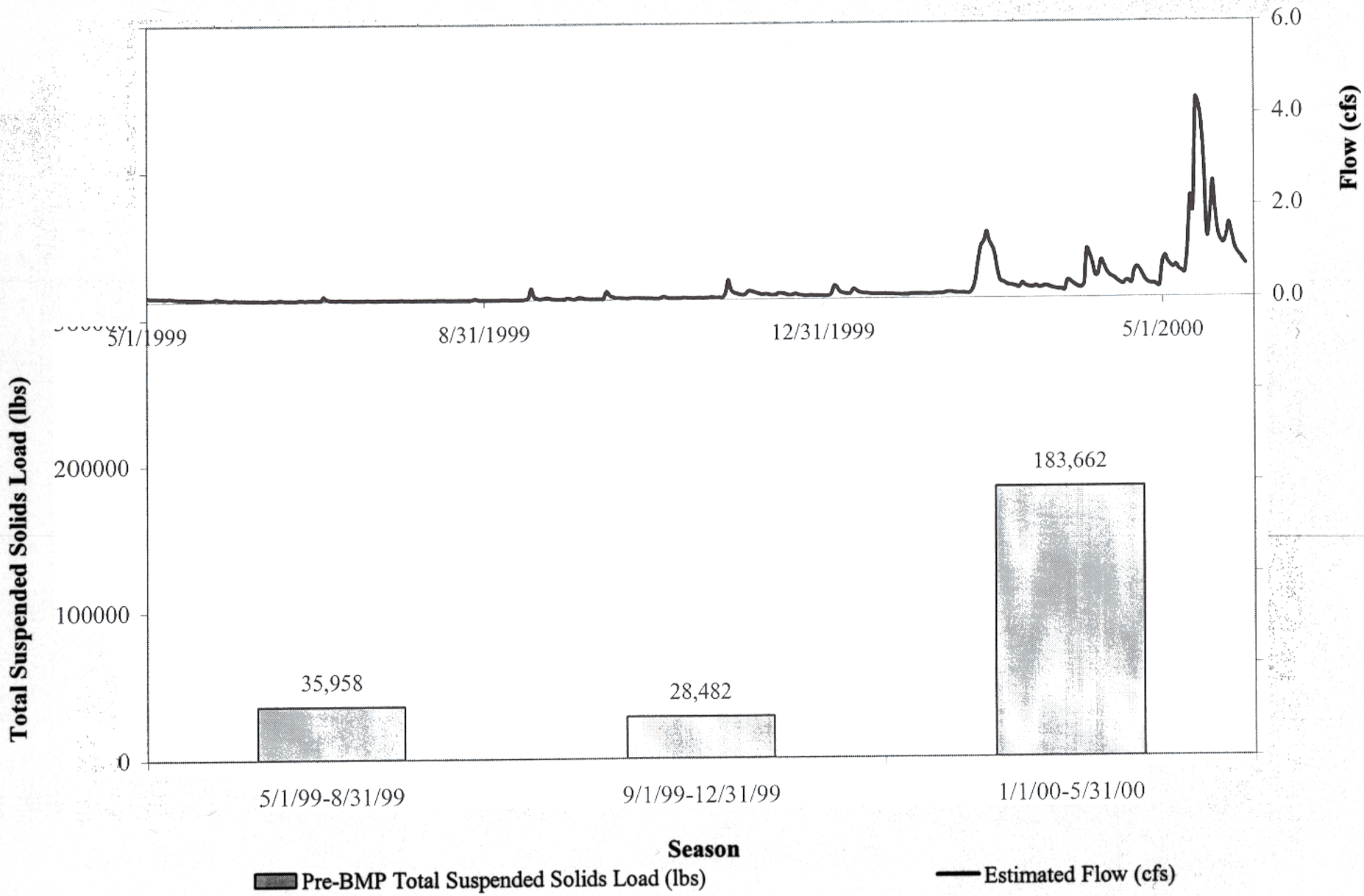
Figure 66



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Post-BMP Hydrograph andOrtho-Phosphorus Loading

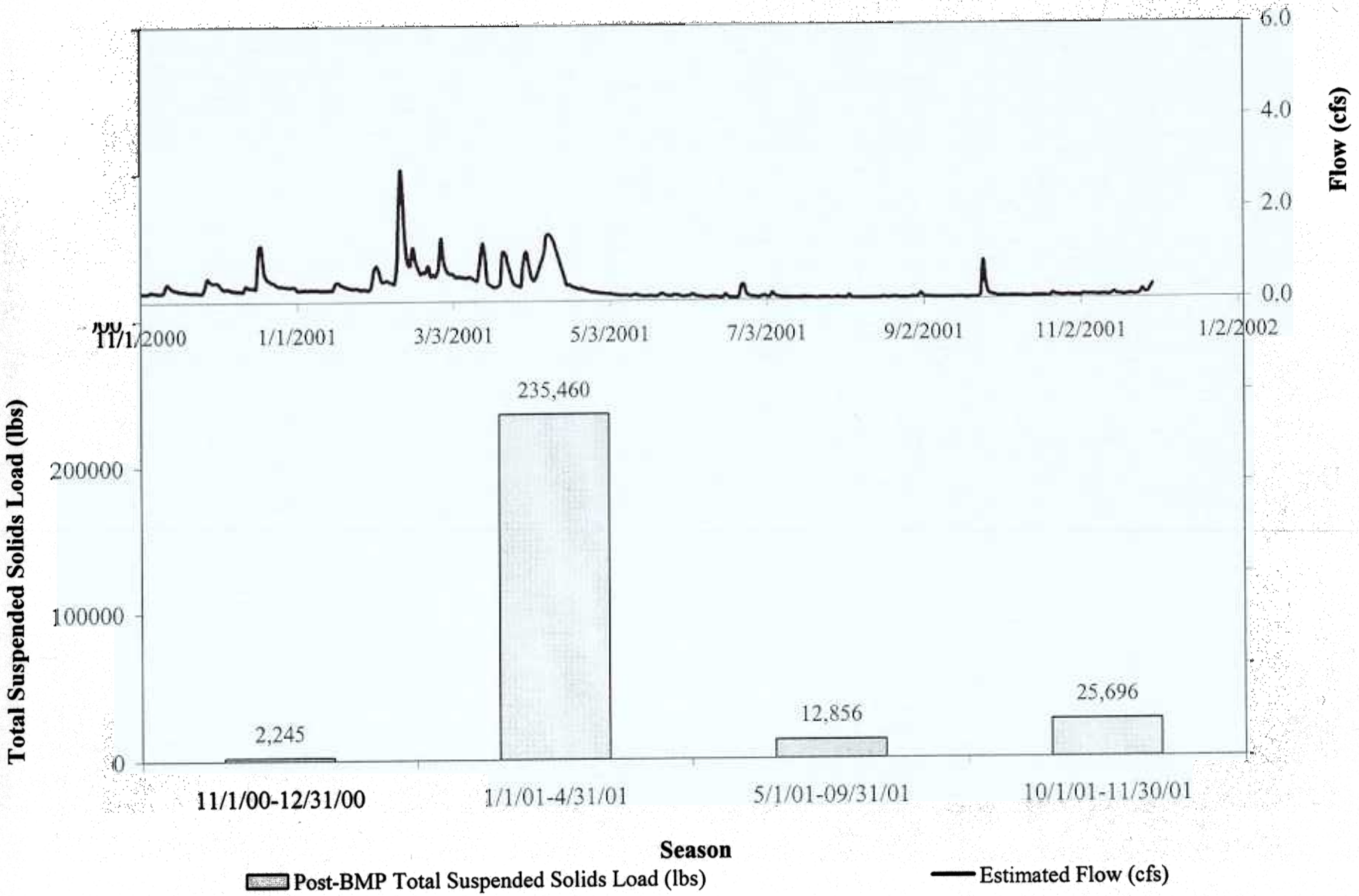
Figure 67



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph and TSS Loading

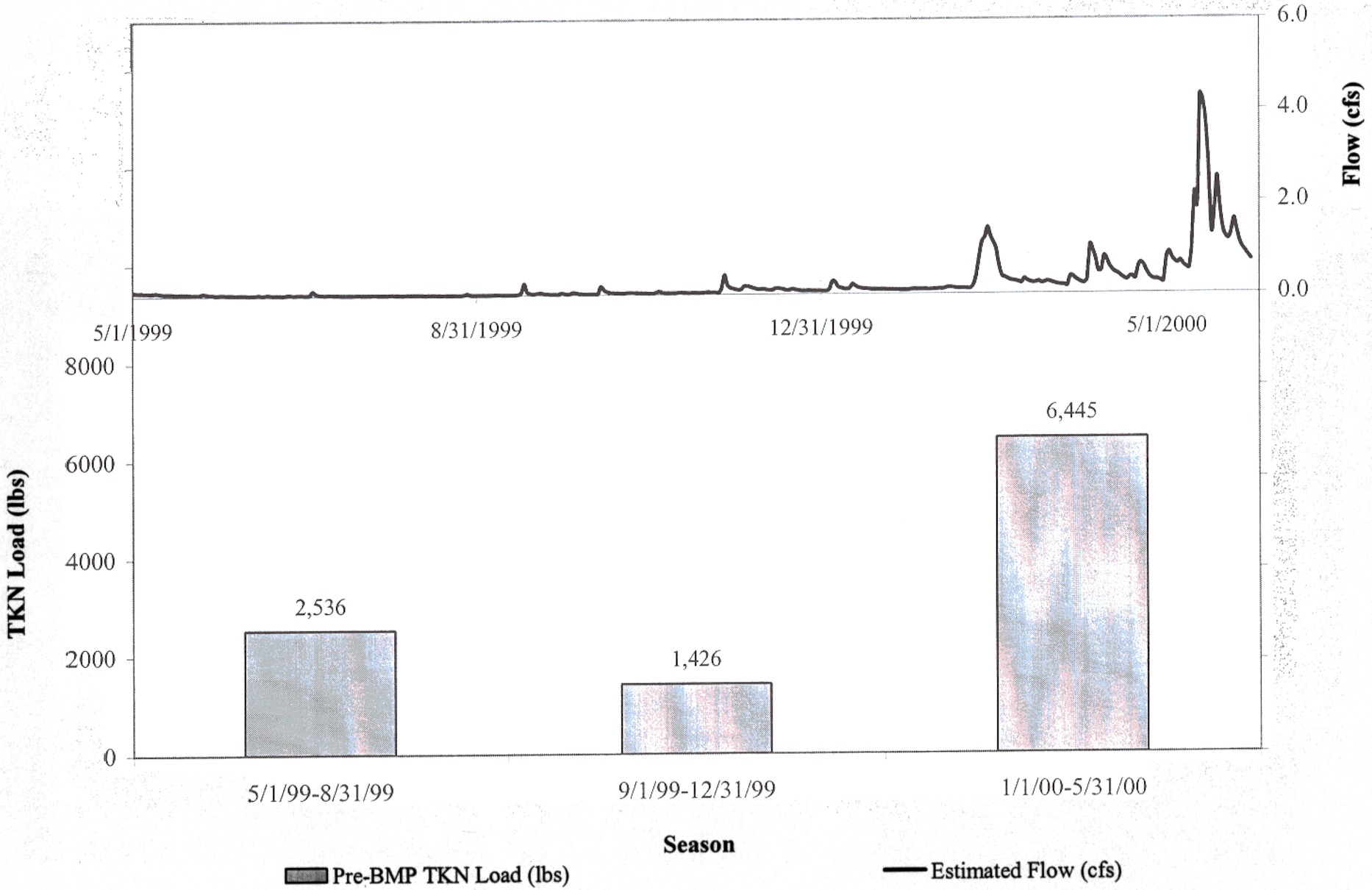
Figure 68



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph and TSS Loading

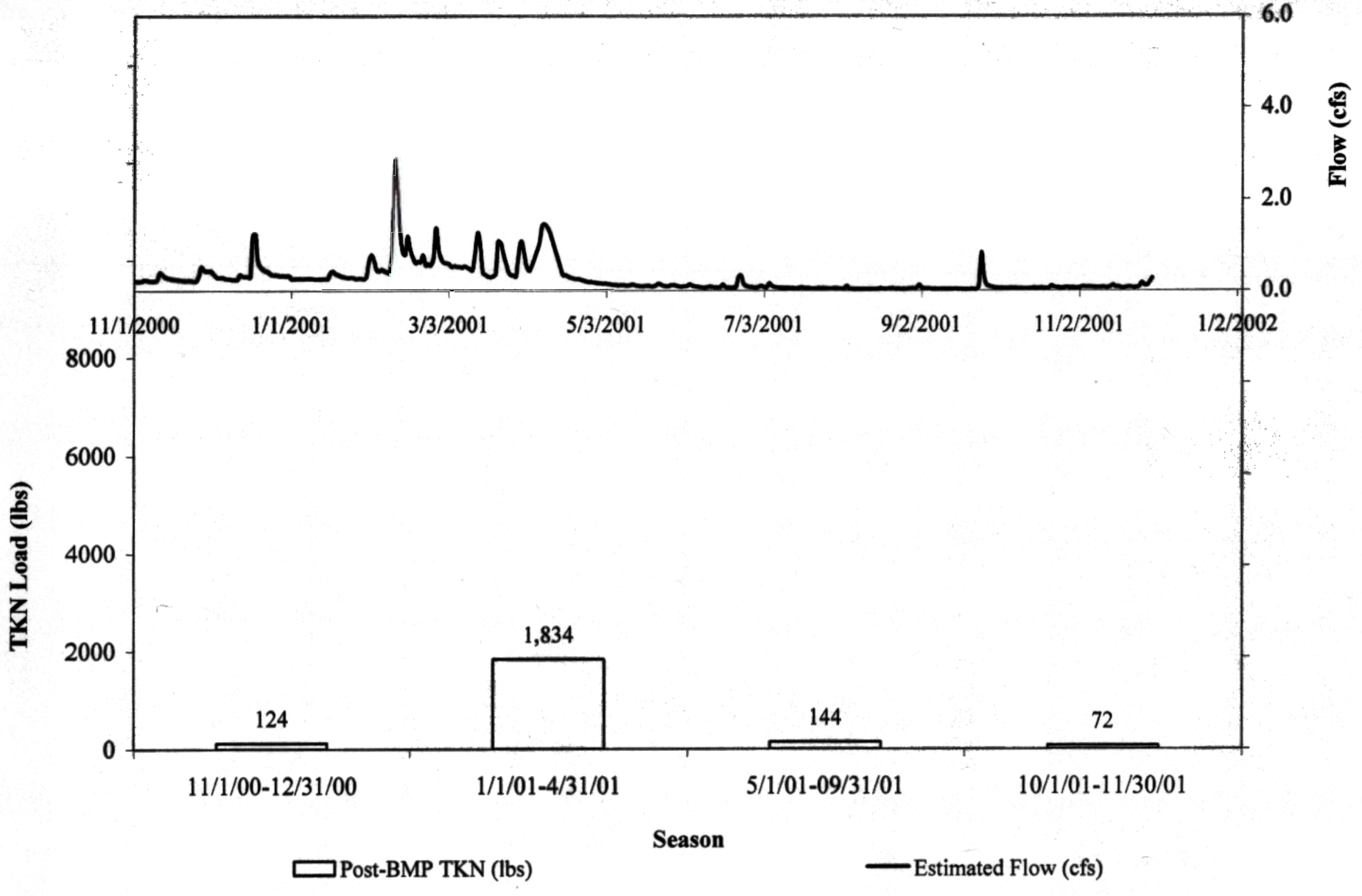
Figure 69



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

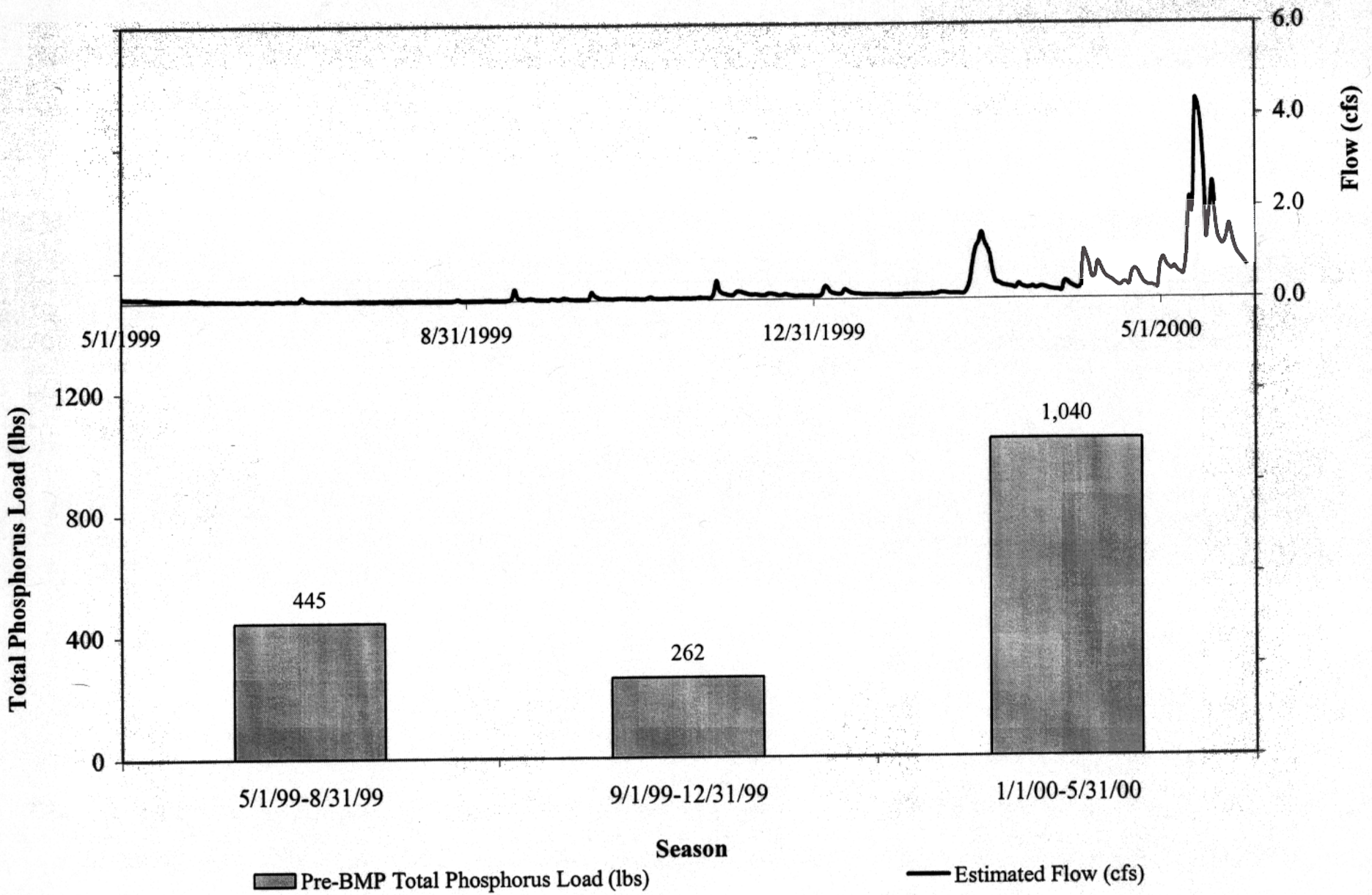
Figure 70



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

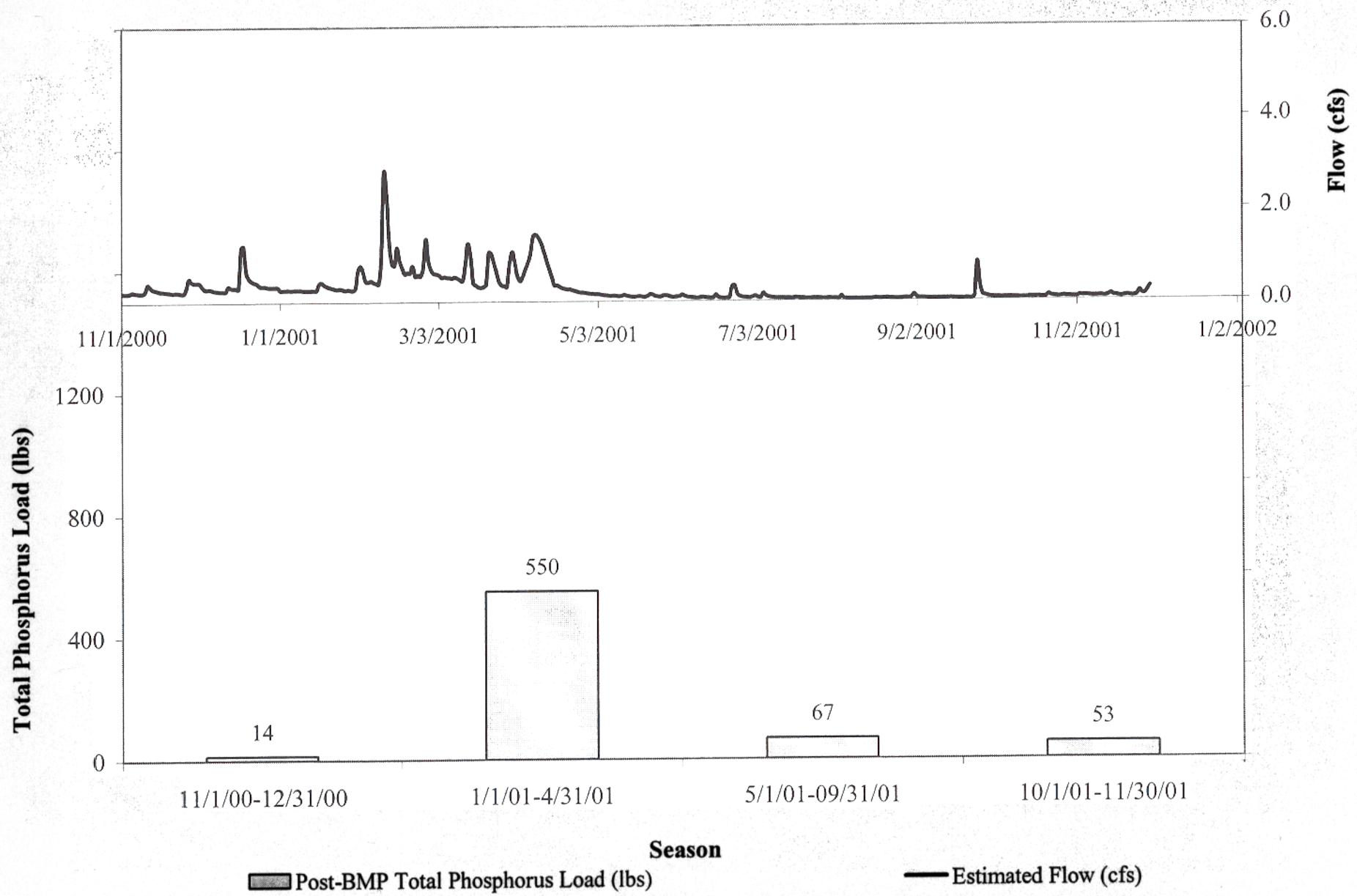
Figure 71



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph and Total Phosphorus Loading

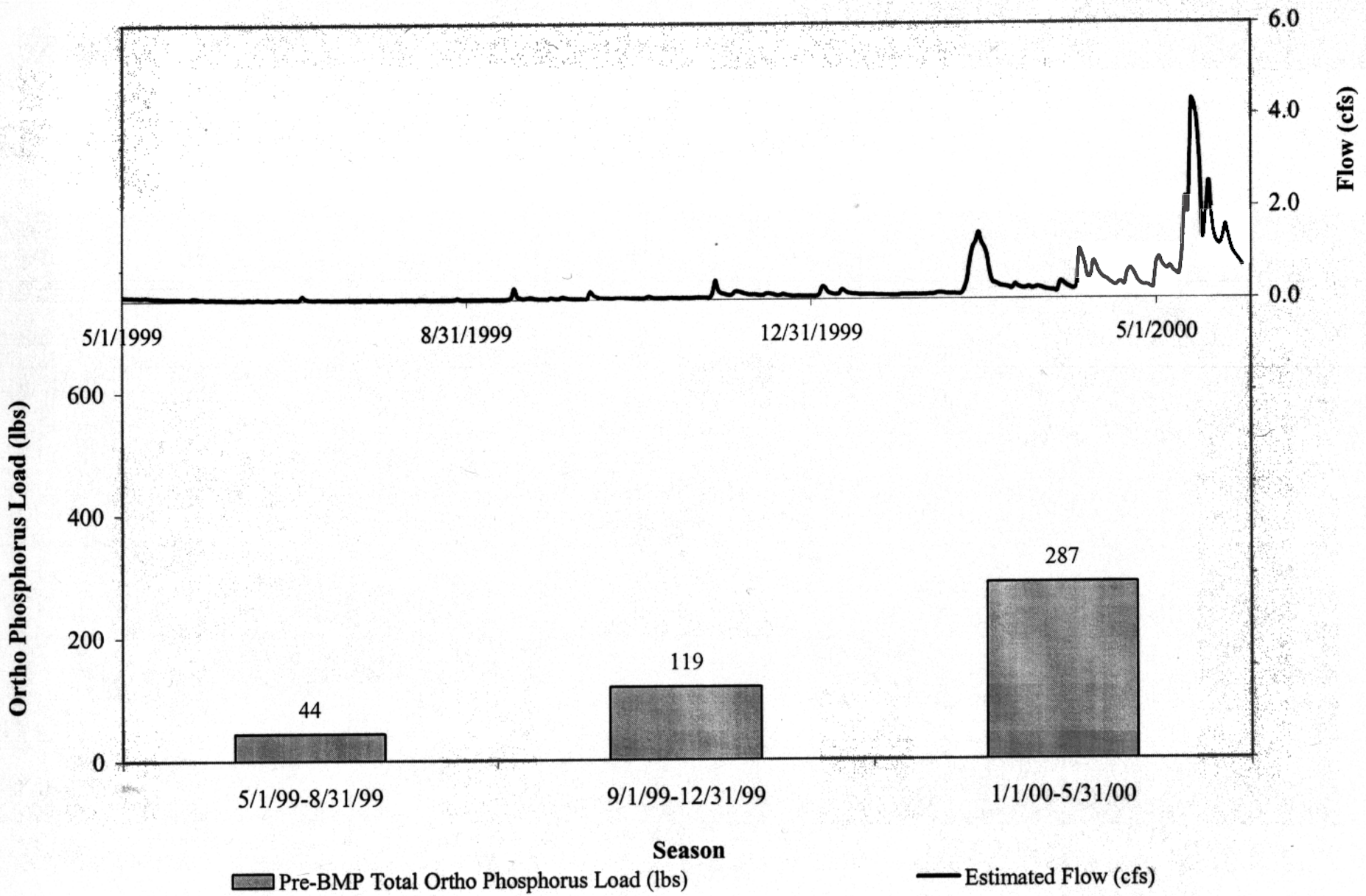
Figure 72



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph and Total Phosphorus Loading

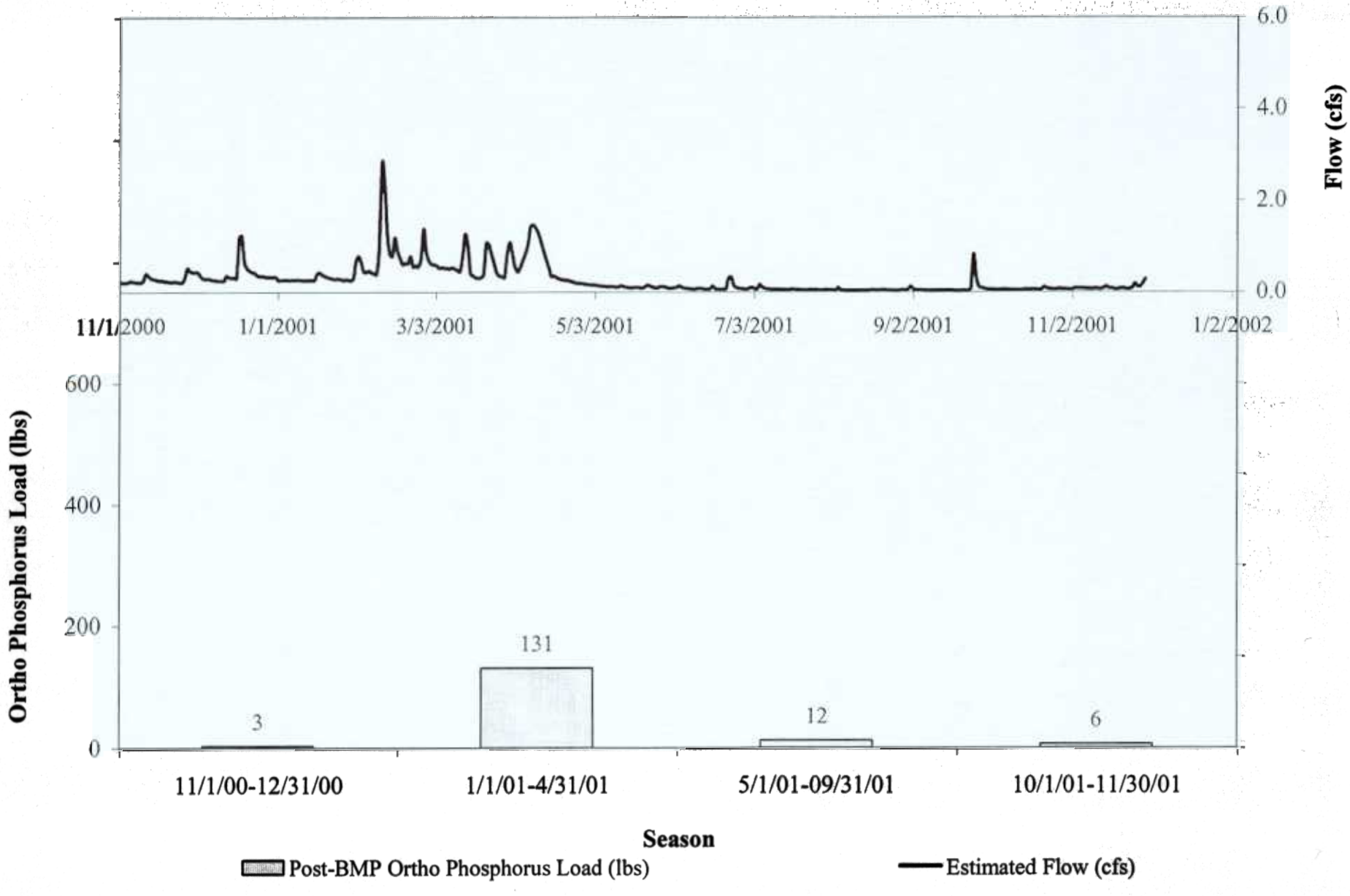
Figure 73



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Pre-BMP Hydrograph and Ortho-Phosphorus Loading

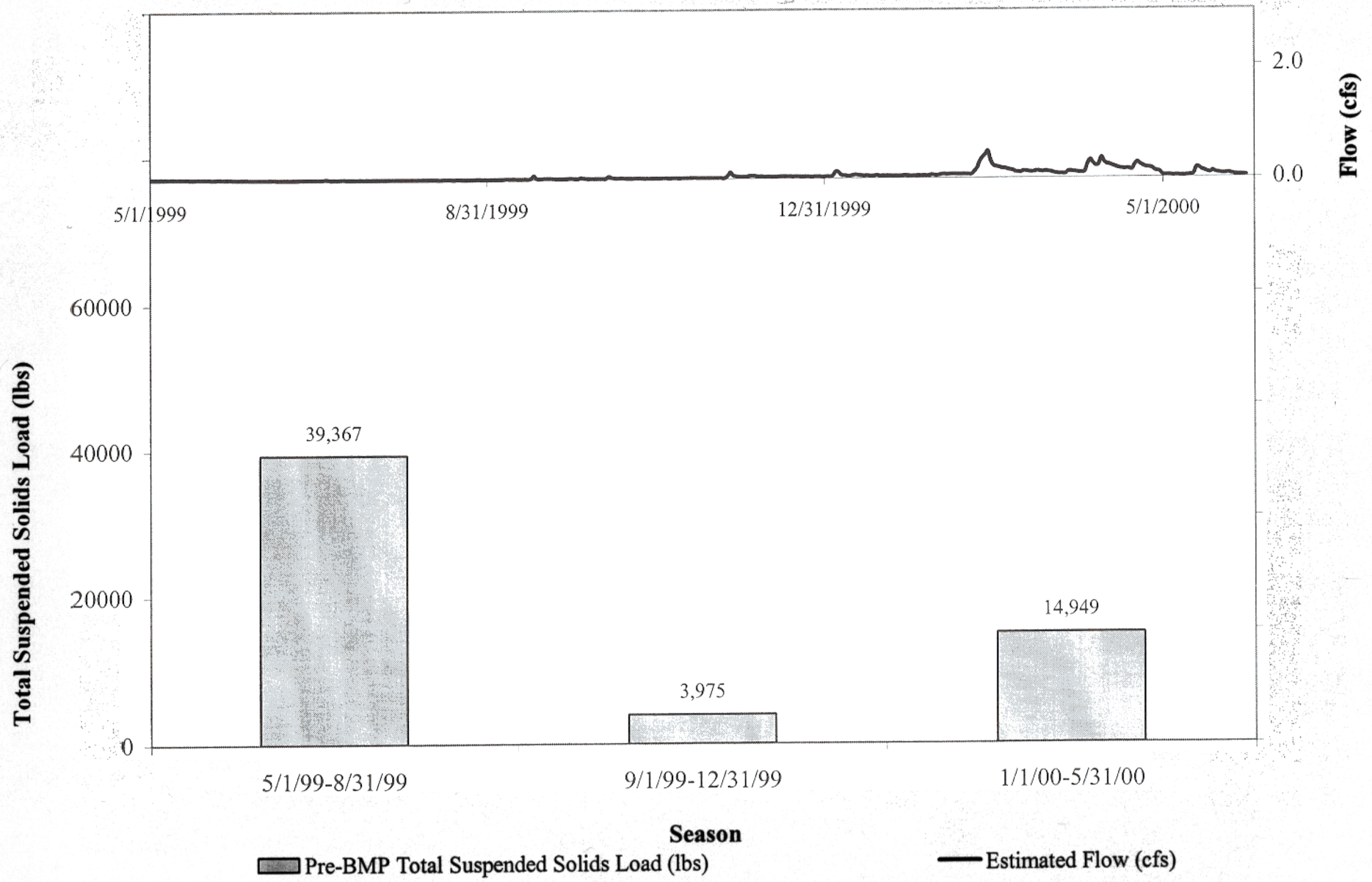
Figure 74



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Guptill Farm Post-BMP Hydrograph and Ortho-Phosphorus Loading

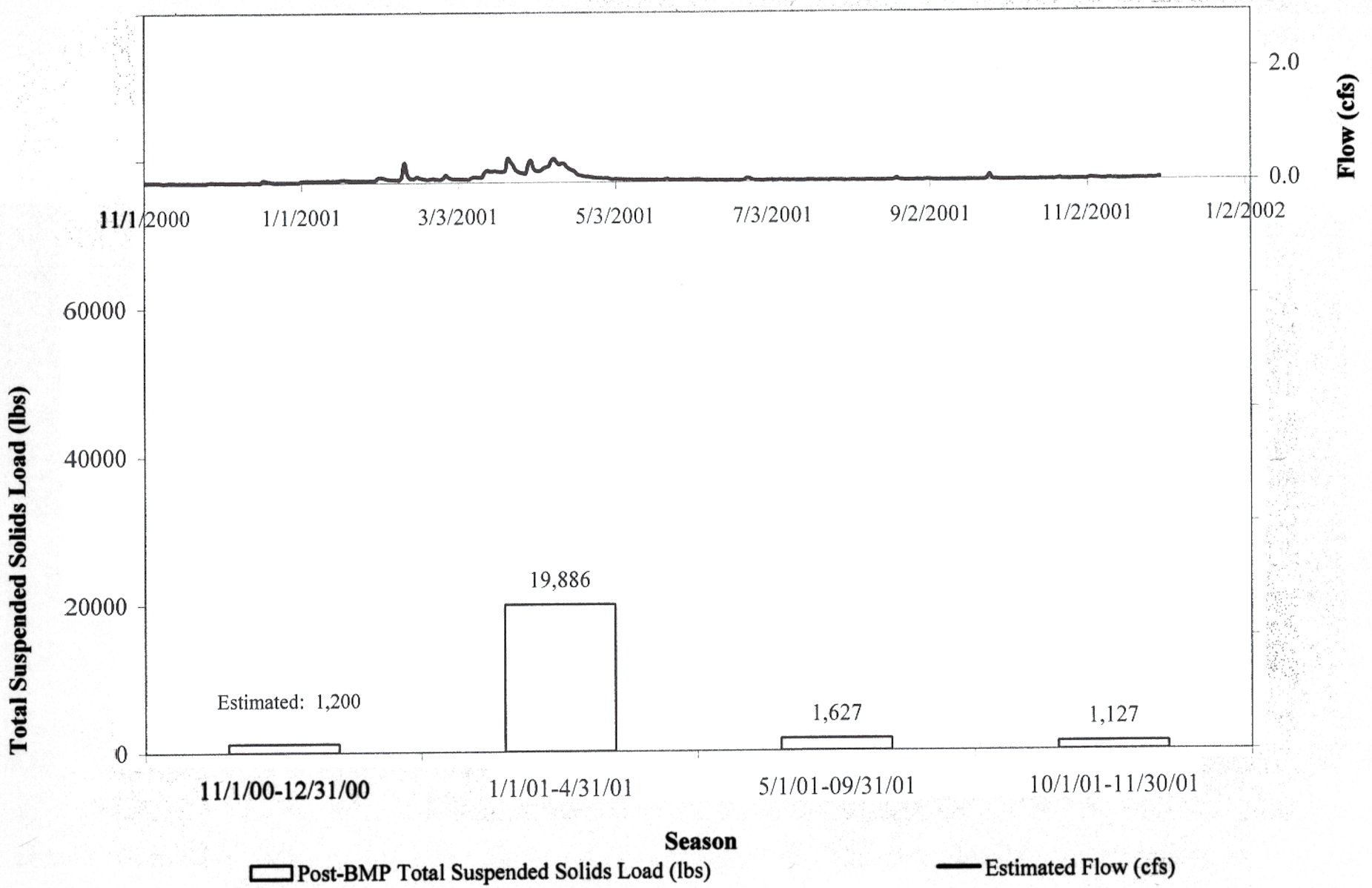
Figure 75



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre-BMP Hydrograph and TSS Loading

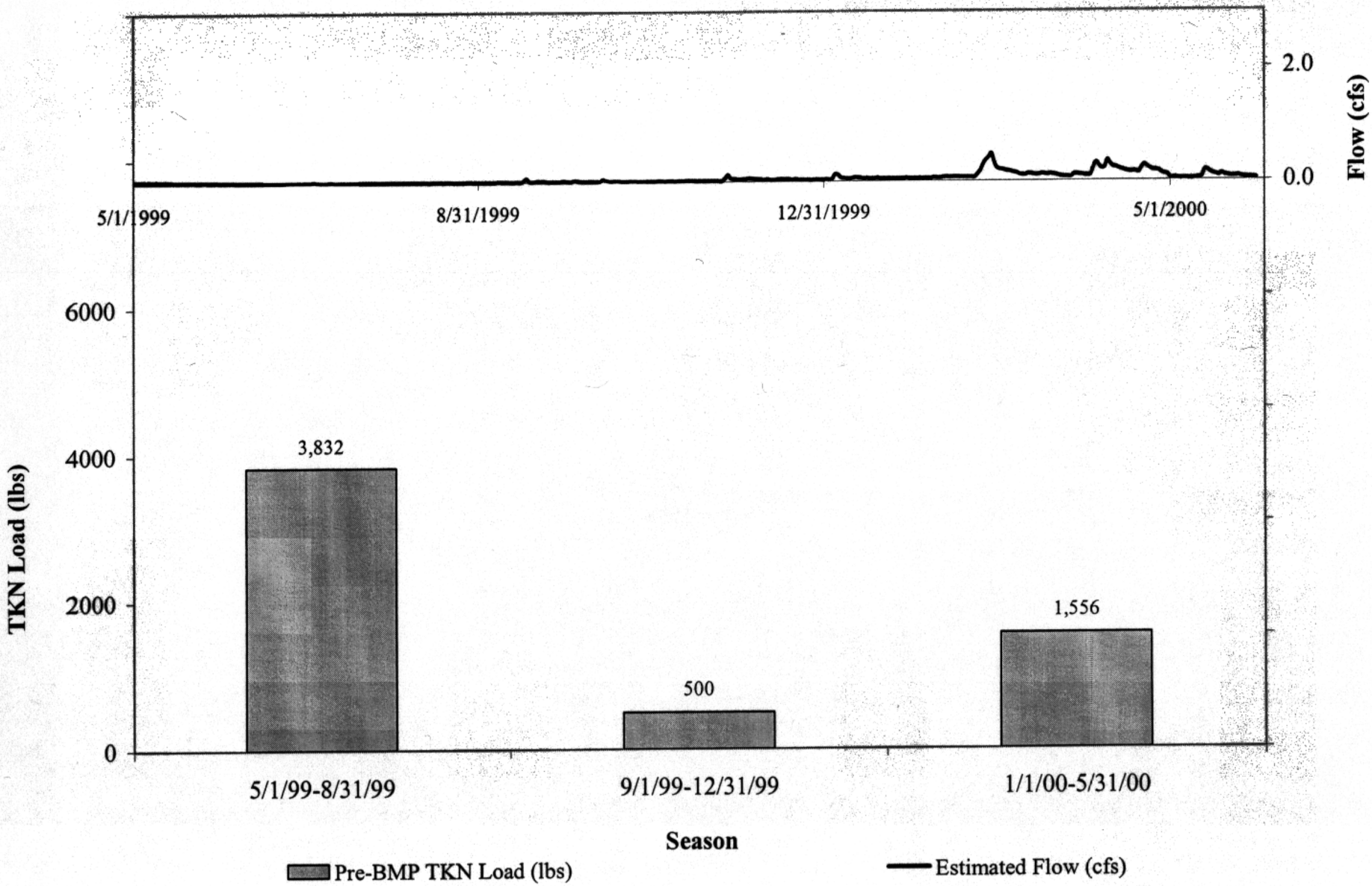
Figure 76



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Post-BMP Hydrograph and TSS Loading

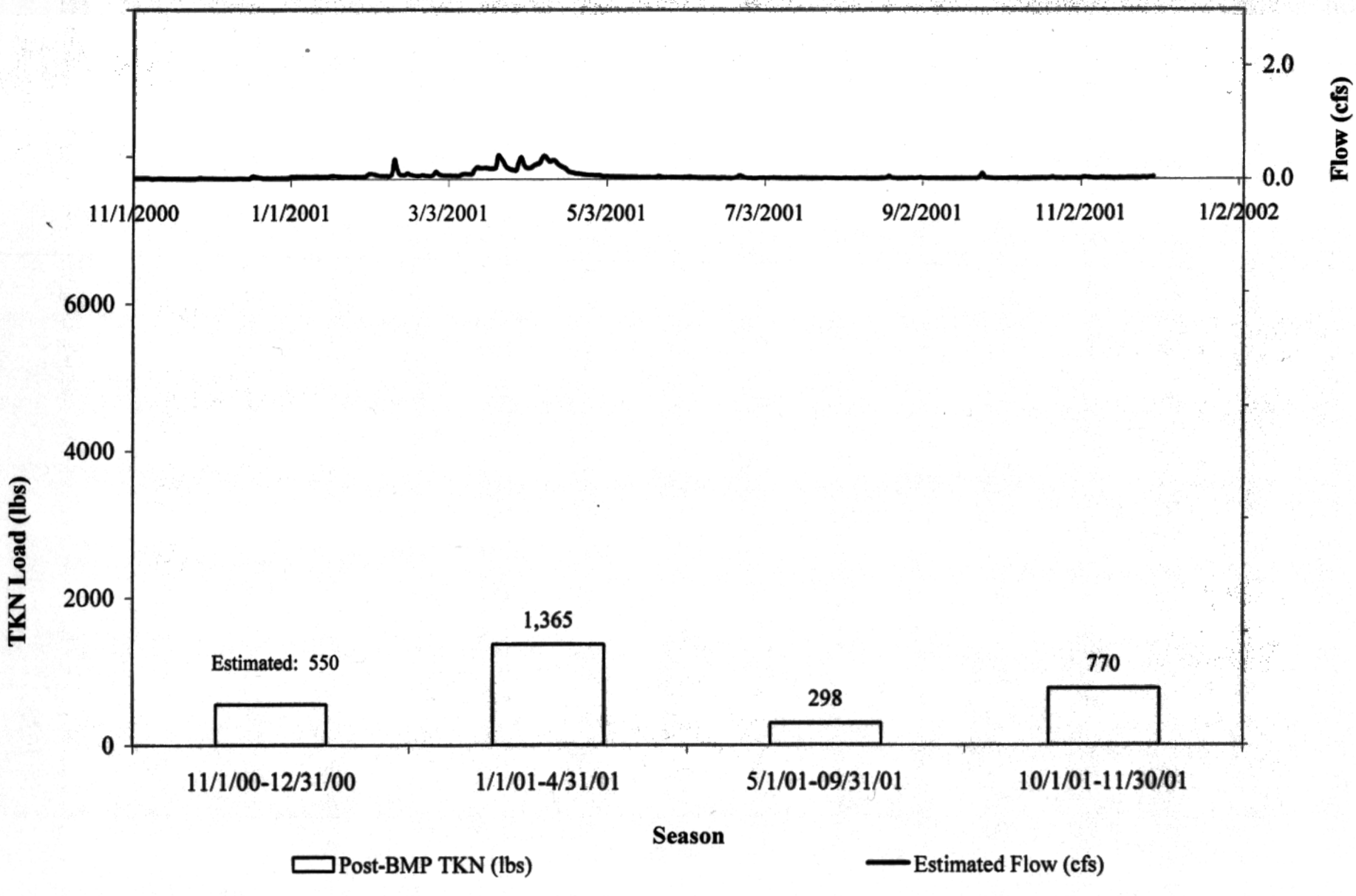
Figure 77



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

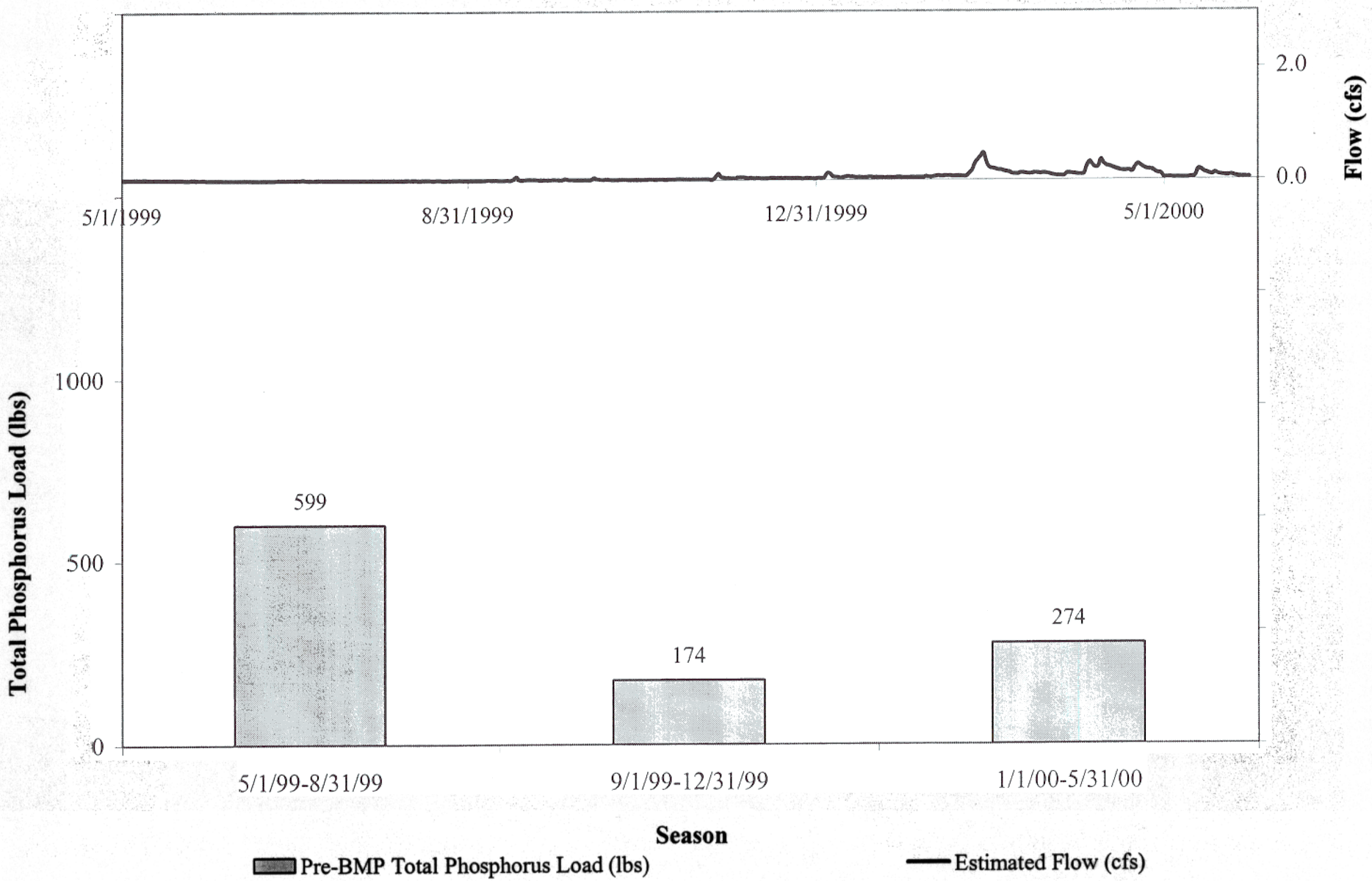
Figure 78



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Post-BMP Hydrograph and Total Kjeldhal Nitrogen (TKN) Loading

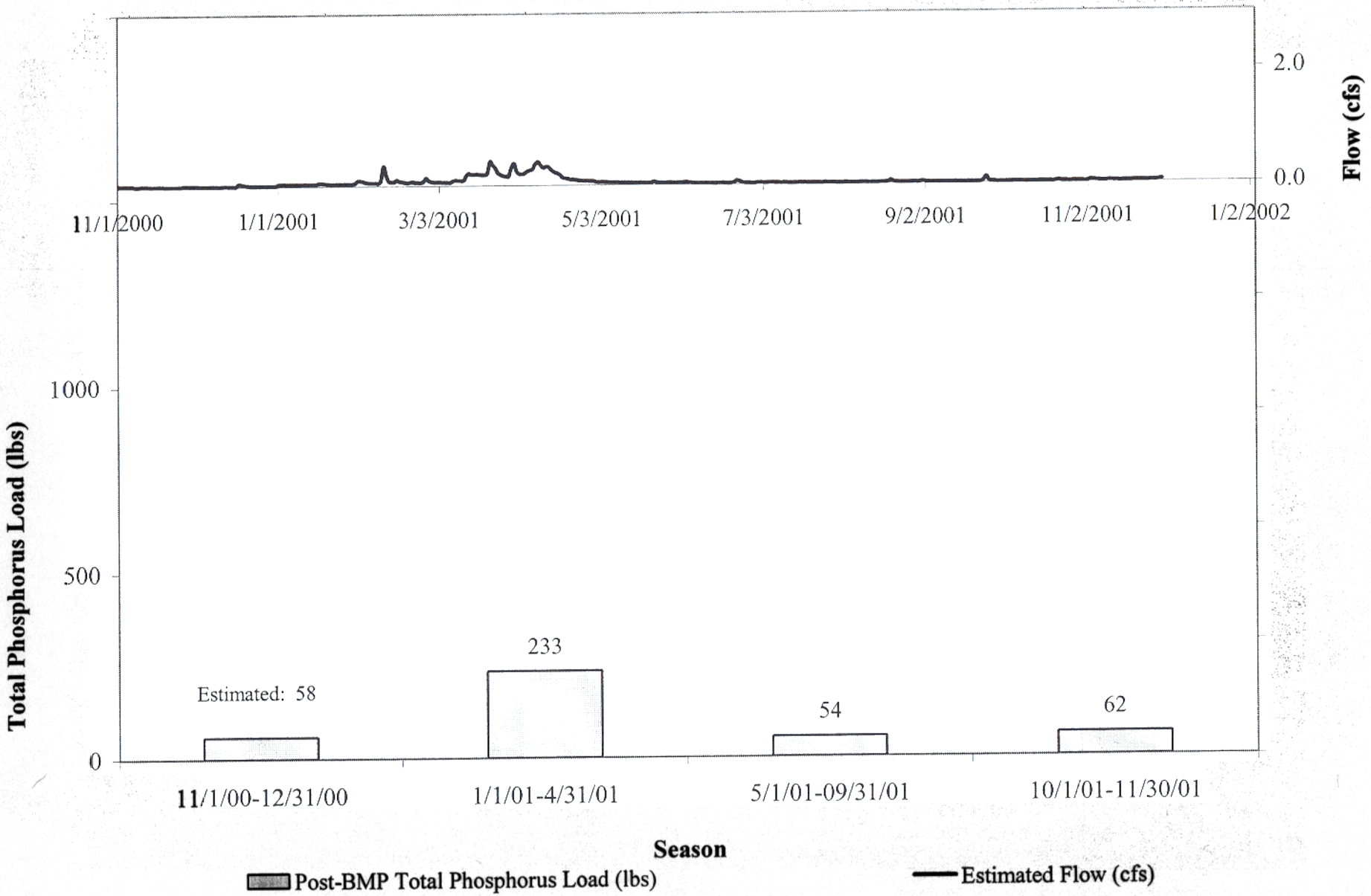
Figure 79



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Pre-BMP Hydrograph and Total Phosphorus Loading

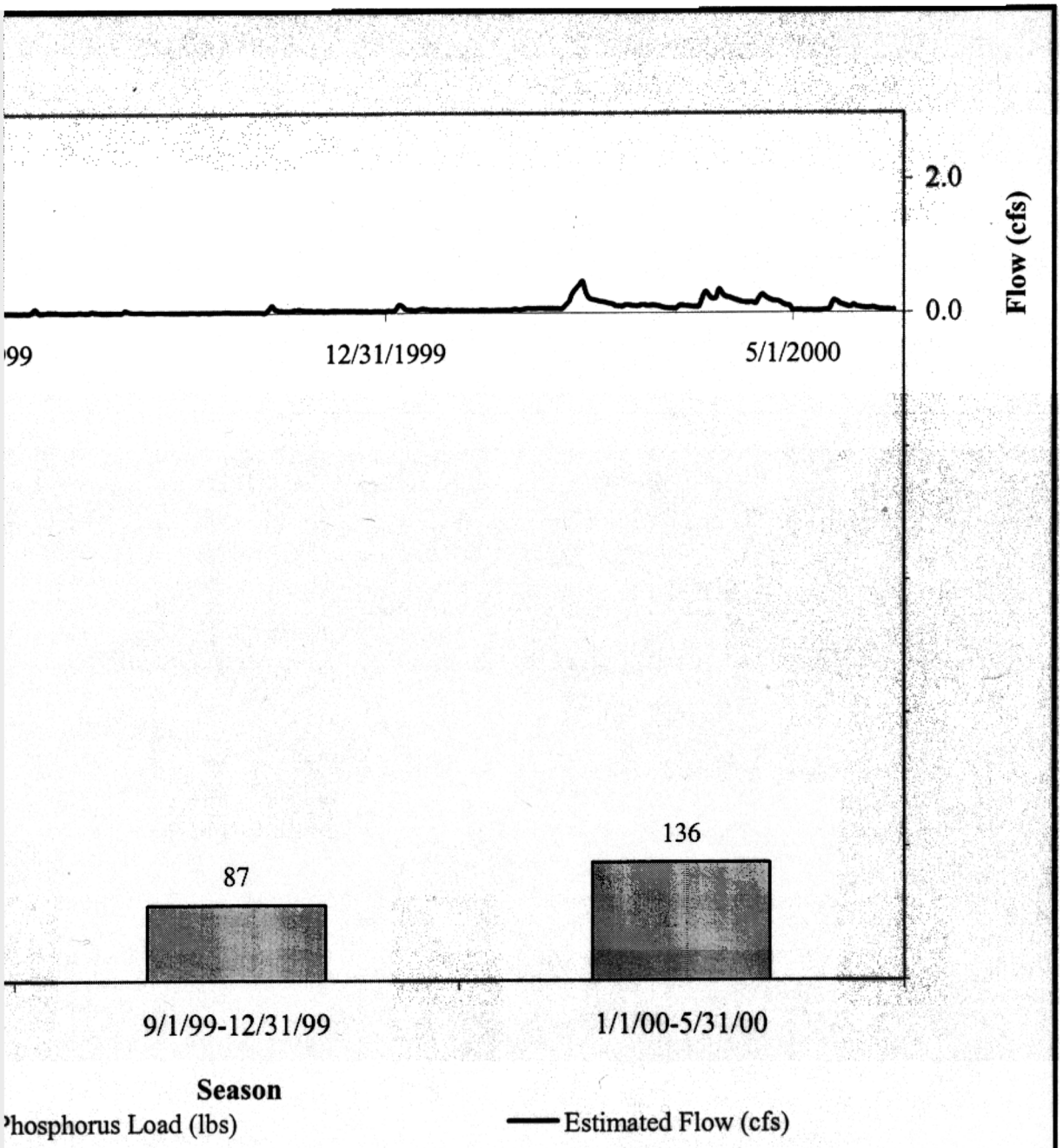
Figure 80



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Leubner Farm Post-BMP Hydrograph and Total Phosphorus Loading

Figure 81



Onondaga Lake Watershed, Nonpoint Source EBP
ner Farm Pre-BMP Hydrograph and Ortho-Phosphorus Loading

Figure 82

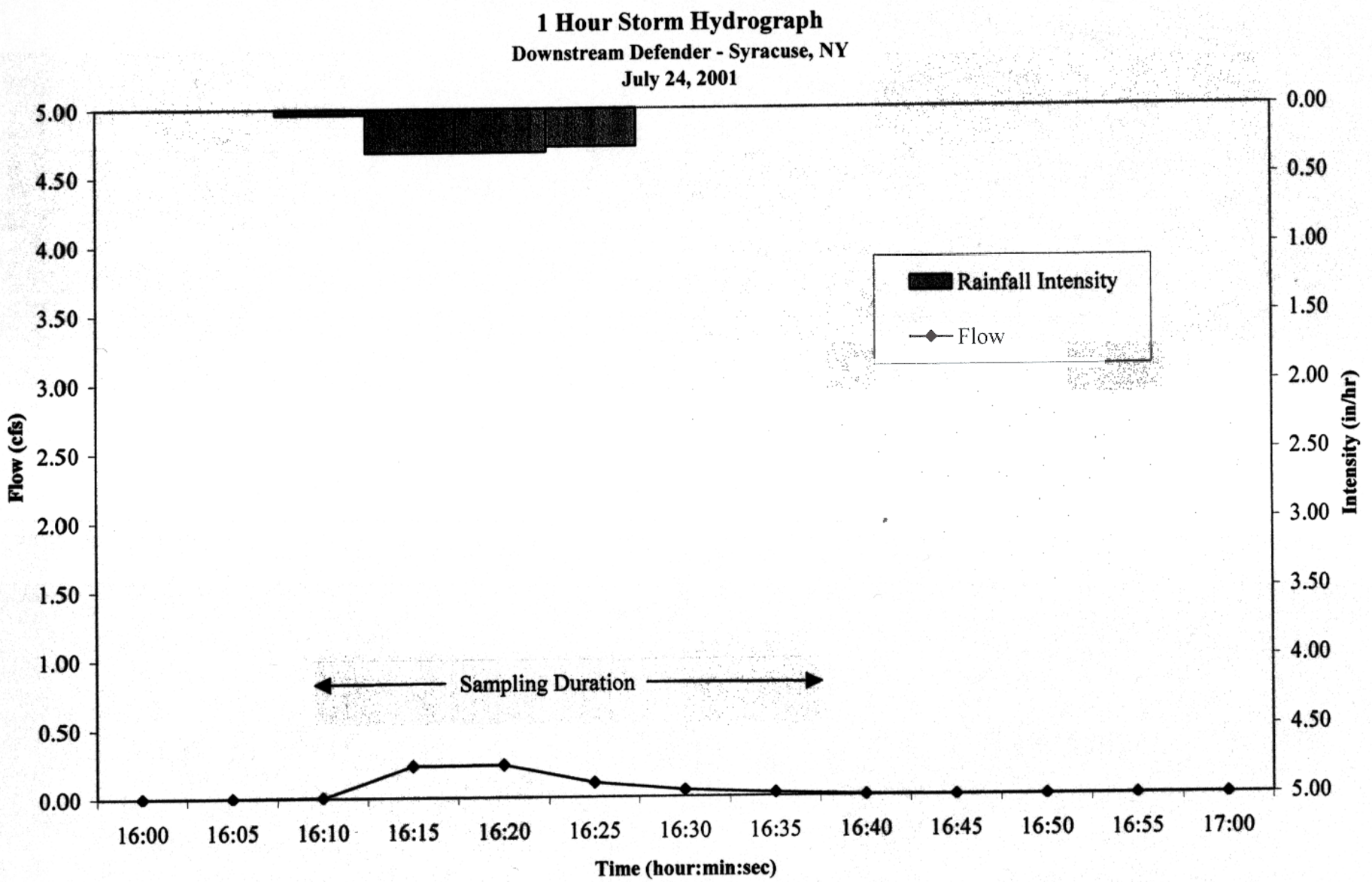
Date of Cleaning	Volume of Stormwater Processed (gallons)	Volume of Material Removed (cubic feet)	Notes
March 1, 2001	NA	20	Not cleaned since installation. Filled beyond capacity. Obvious layer of leaf liter from fall foliage. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
June 25, 2001	227,899	19	Unit filled to near capacity. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
August 21, 2001	95,757	17	Unit filled to near capacity. Influent diversion manhole full. Effluent diversion manhole relatively clean.
November 30, 2001	184,998	19	Unit filled to near capacity. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
March 13, 2002	7,965	20	Filled beyond capacity because of winter build-up of road sand. Influent diversion manhole filled with heavy grit and effluent diversion manhole filled with fine silty material.
April 8, 2002	53,219	15	Unit filled to near capacity. Influent diversion manhole full. Effluent diversion manhole relatively clean.
June 5, 2002	167,802	17	Unit filled to near capacity. Influent diversion manhole full. Effluent diversion manhole relatively clean.
Total	**737,640**	**107**	

Notes: March 1, 2001 not included in totals. Evaluation started on March 1, 2001.

The mass of the material captured (4,500 lbs) was estimated based on volume removed and specific gravity of material.

During the period from November 30, 2001 and March 13, 2002 the unit processed stormwater derived from, which was not included in the 7,965 gallons.

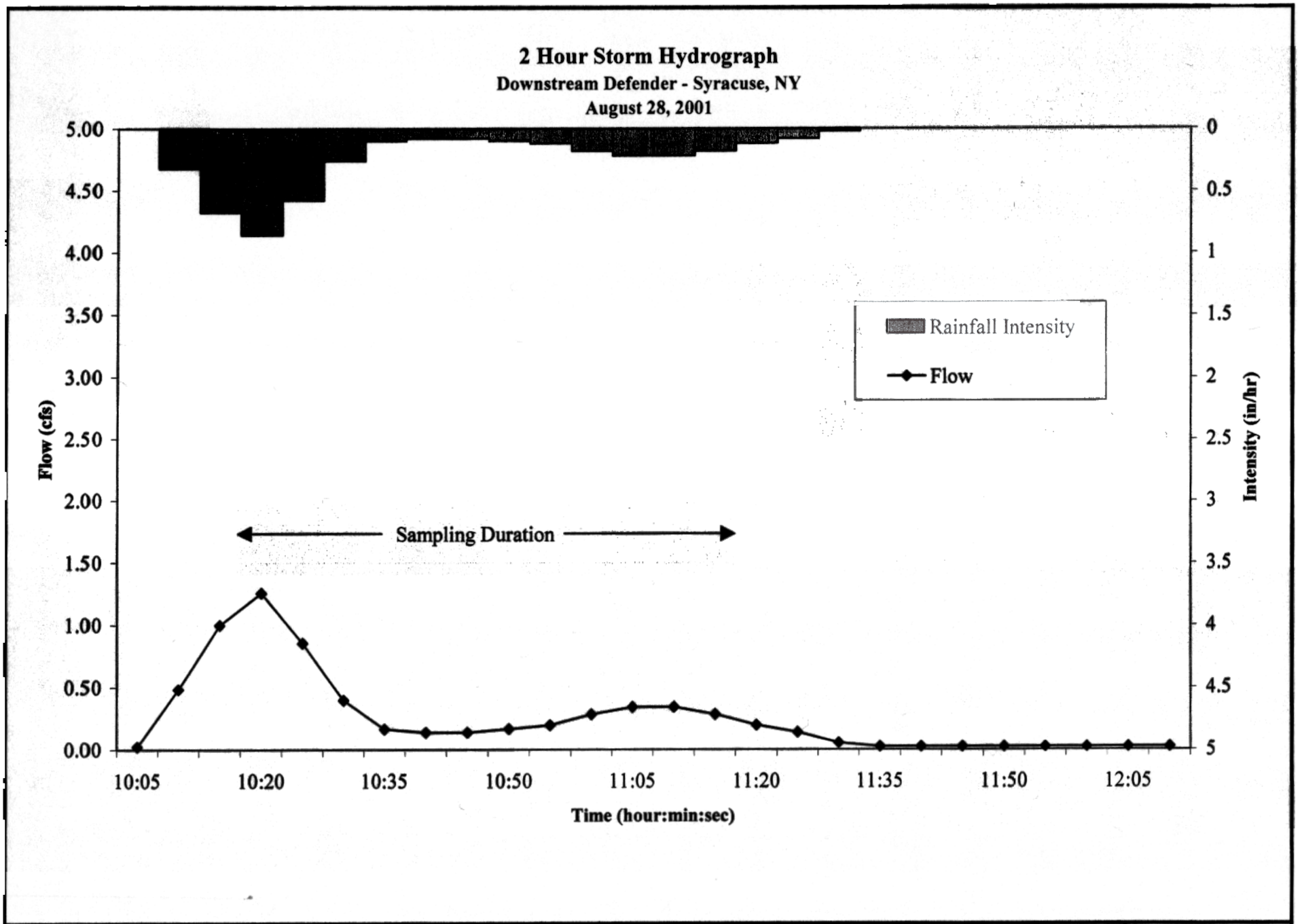
During this period approximately 50 inches of snow fell with a water equivalence of 3.8 inches.



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
1 Hour Storm Hydrograph-Downstream Defender - July 24, 2001

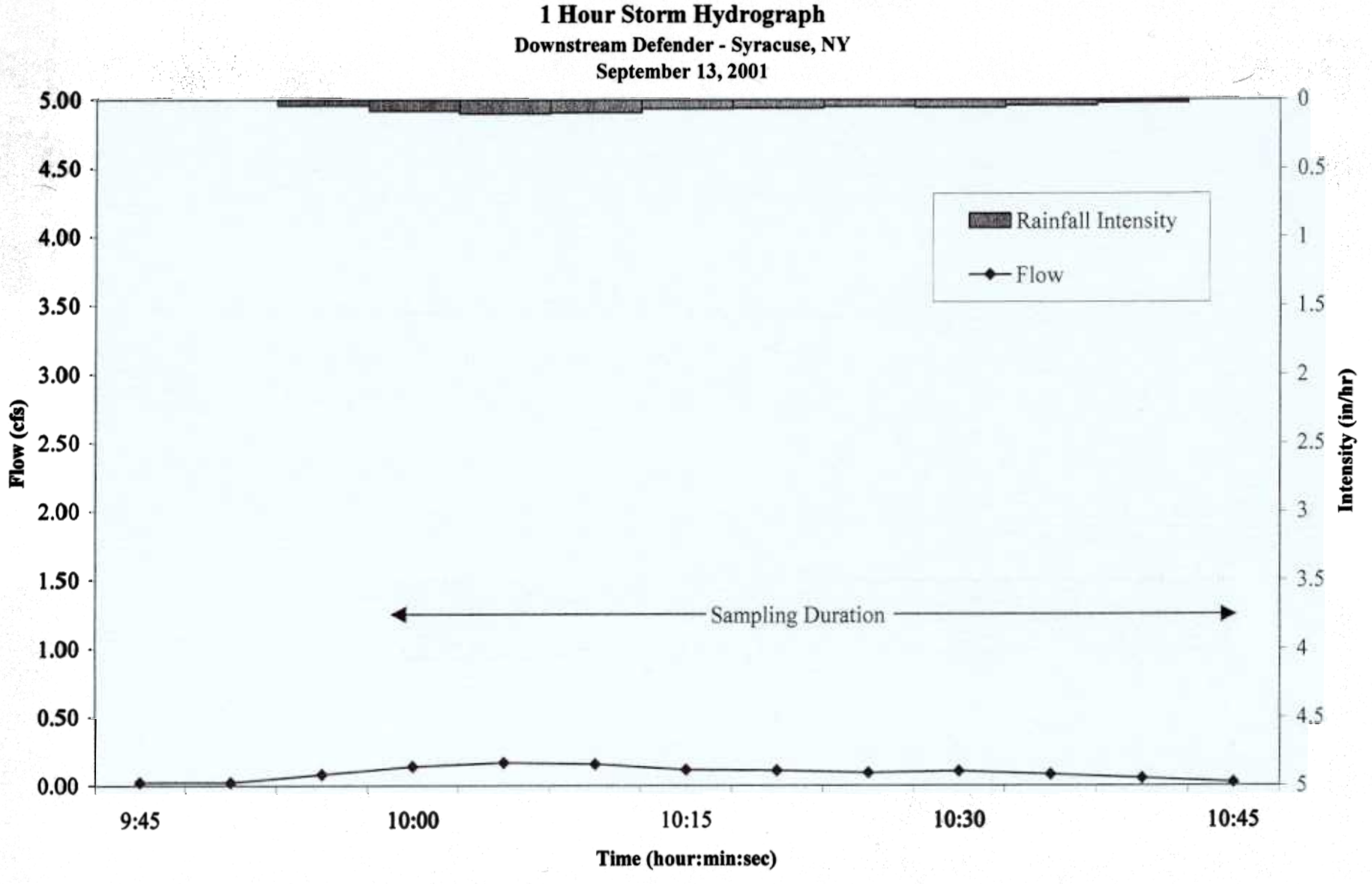
Figure 84



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
2 Hour Storm Hydrograph-Downstream Defender -August 28, 2001

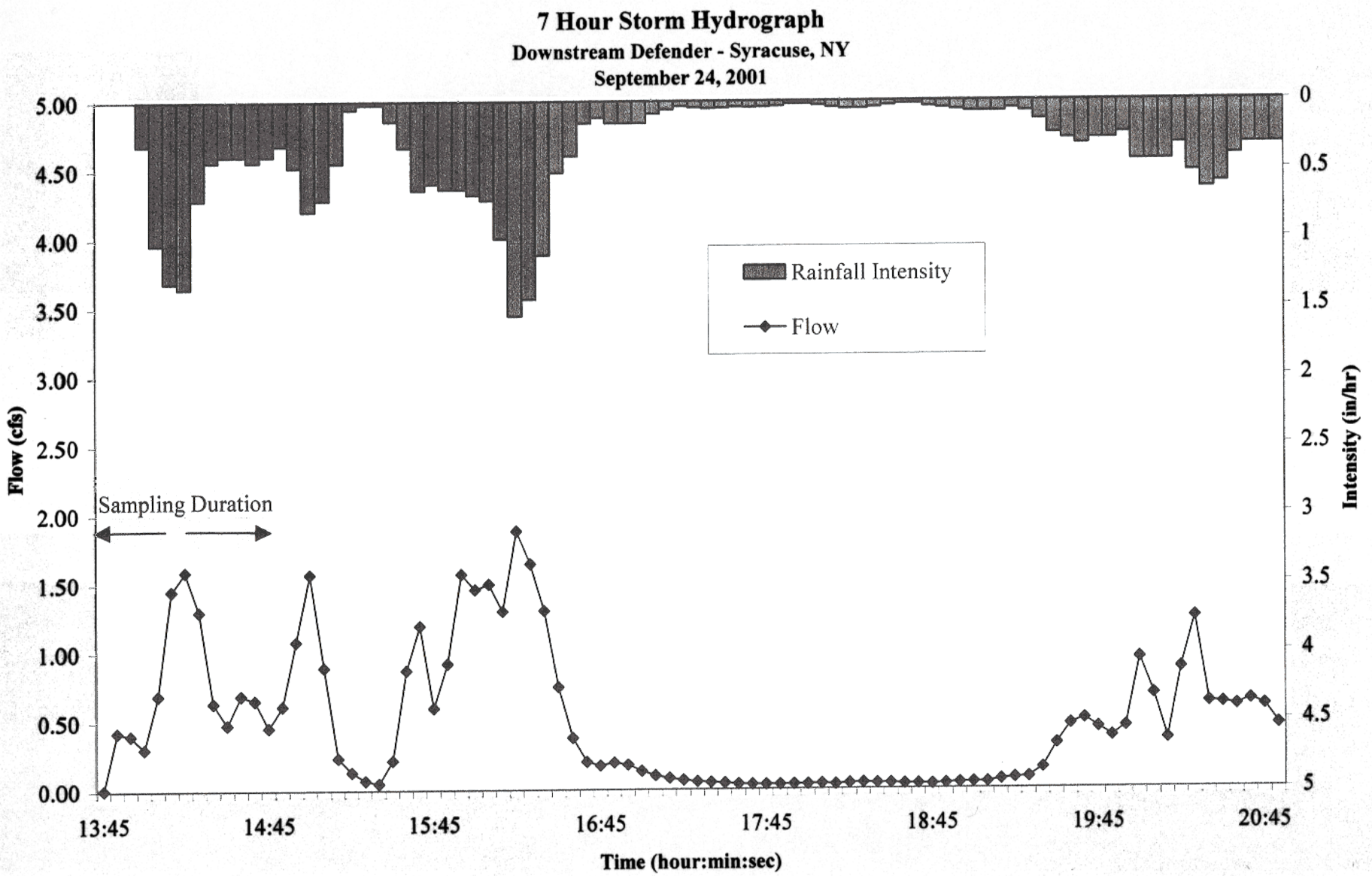
Figure 85



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
1 Hour Storm Hydrograph-Downstream Defender-September 13, 2001

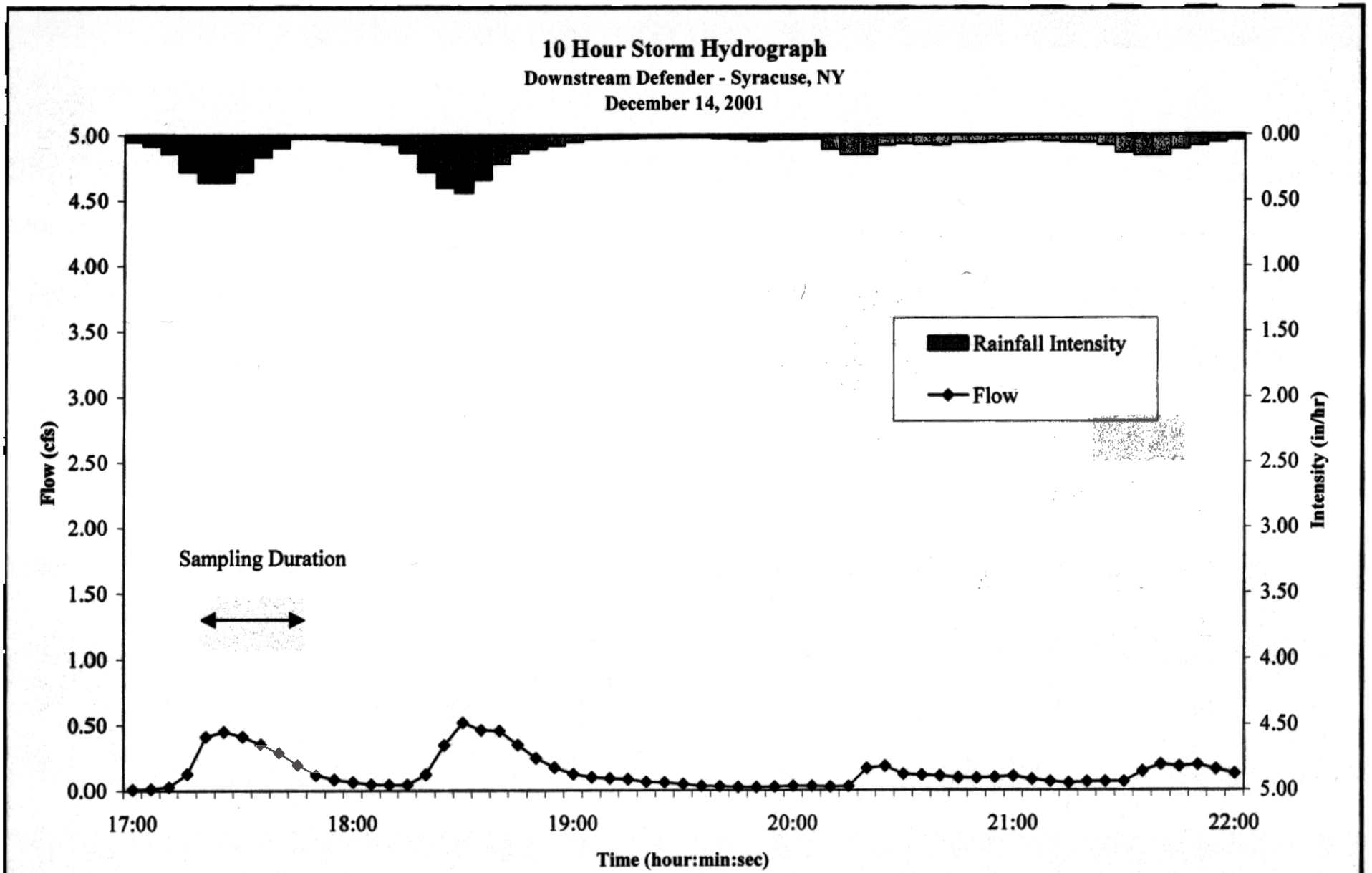
Figure 86



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
7 Hour Storm Hydrograph-Downstream Defender-September 24, 2001

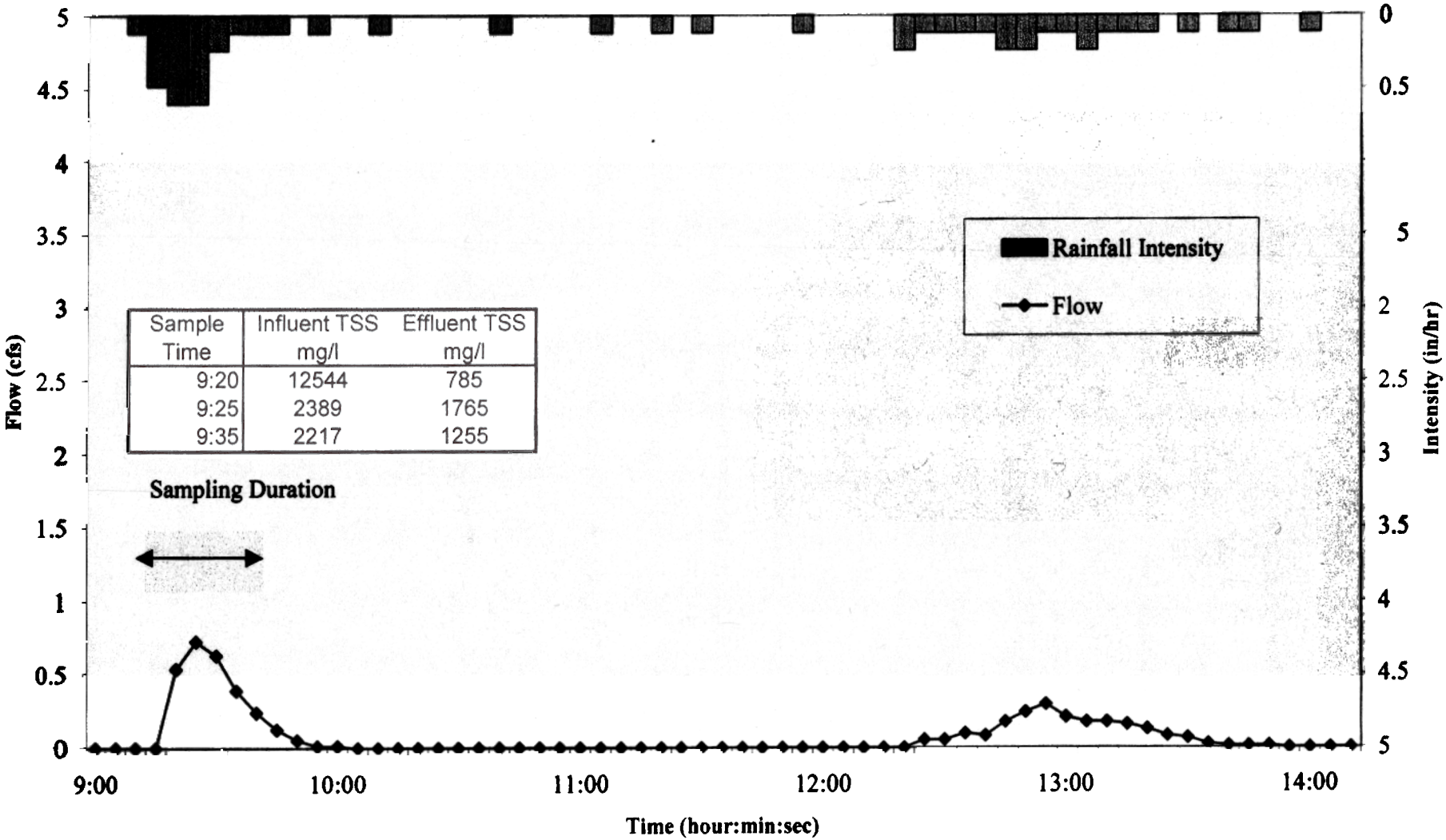
Figure 87



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
10 Hour Storm Hydrograph-Downstream Defender-December 14, 2001

Figure 88

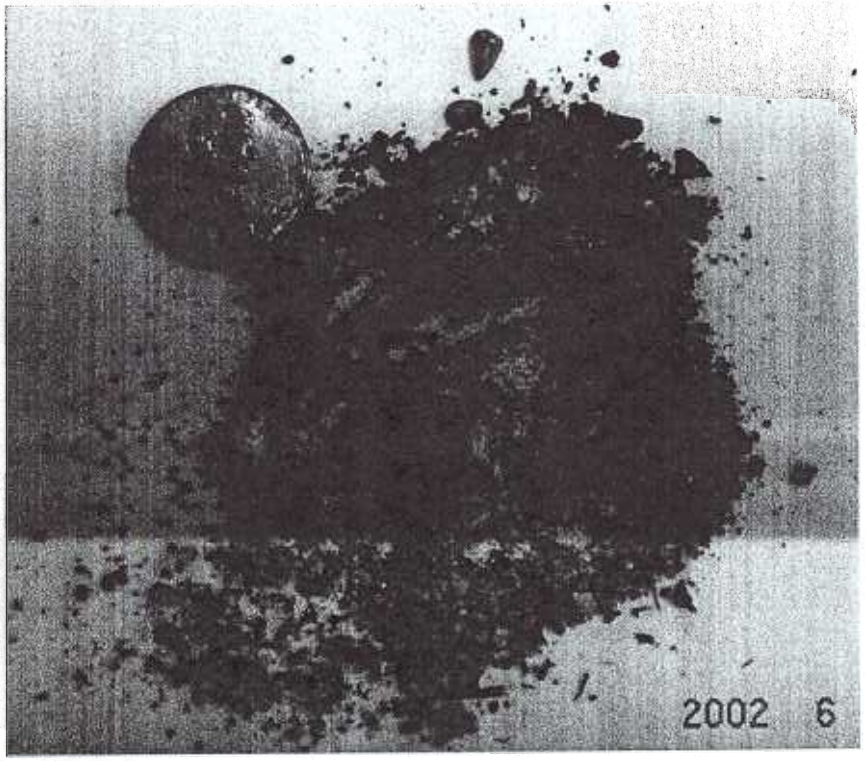


Sample Time	Influent TSS mg/l	Effluent TSS mg/l
9:20	12544	785
9:25	2389	1765
9:35	2217	1255

Moffa & Associates
A unit of Brown and Caldwell

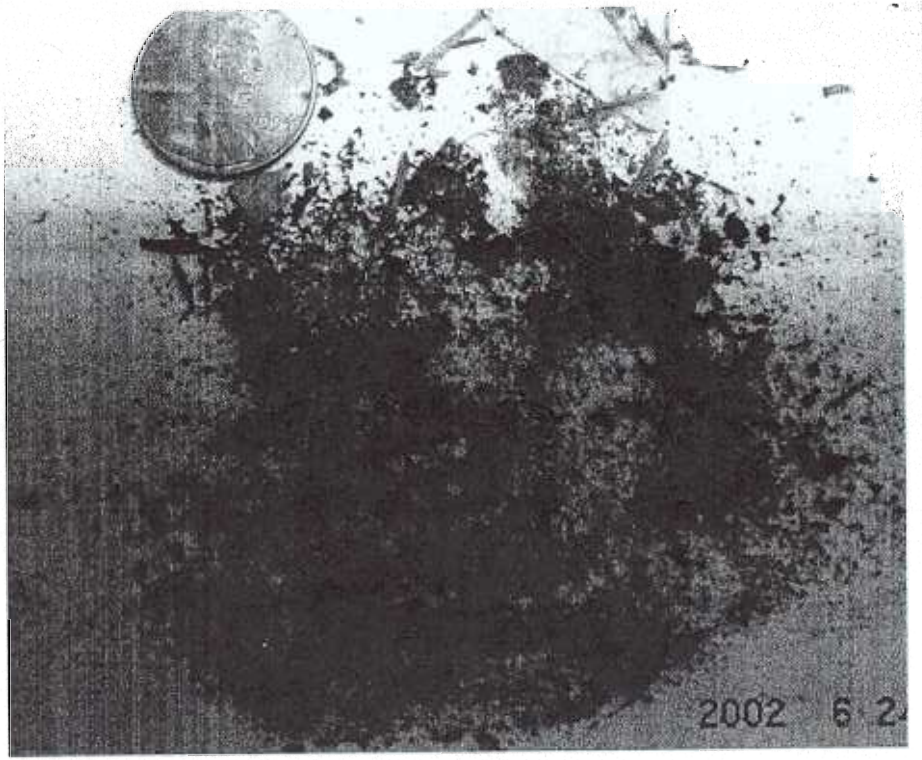
Onondaga Lake Watershed, Nonpoint Source EBP
5 Hour Storm Hydrograph-Downstream Defender-April 25, 2002

Figure 89



Influent Stormwater Vortex Unit Solids Sample: Coarse to Medium Grit

Effluent Stormwater Vortex Unit Solids Sample: Fine Grit and Organics



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Influent and Effluent Solids - Downstream Defender-April 25, 2002

Figure 90

Percent Passing Sieve	
#4	98
#10	91
#30	53
#40	38
#60	18
#100	9
#200	4

Parameter	Result (mg/kg)	Mass of Pollutant* (lbs)
Arsenic	2.1	0.01
Barium	30	0.13
Cadmium	2	0.01
Chromium	65	0.29
Copper	31	0.14
Lead	170	0.76
Mercury	0.2	0.00
Nickel	9	0.04
Selenium	0.8	0.00
Silver	2	0.01
Zinc	180	0.81
Total Phos	210	0.94

Note: * Mass Pollutant Captured based on 4,500 lbs total Solids Captured During Study Period

Zoo Influent/Parking Lot							Zoo Effluent/Veg Strip						
Date	Influent #	Time	TSS (mg/l)	TKN (mg/l)	TP (mg/l)	ortho P (mg/l)	Date	Effluent #	Time	TSS (mg/l)	TKN (mg/l)	TP (mg/l)	ortho P (mg/l)
6/23/2001	1	600	300	<0.5	0.2	0.01	6/23/2001	1	600	100	2.13	1.5	1
7/24/2001	1	1300	193	1.02	0.04	0.08							
8/9/2001	1	1000	154	<0.5	0.04	0.08	8/9/2001	1	1330	35	1.32	0.45	0.32
8/31/2001	1	1200	140	<0.5	0.04	0.02	8/31/2001	1	1200	20	1.85	0.56	0.4
9/10/2001	1	1330	283	1.54	0.3	0.1							
10/6/2001	1	1134	120	<0.5	0.06	0.02							

8 LESSONS LEARNED

Lessons were learned during the implementation of BMPs on the farms and in the urban settings as well during sampling and monitoring of the BMPs. These lessons are discussed in the following subsections.

Agricultural BMPs

This project provided a number of learning opportunities for the project team and the participating farms. The unique structure of the consent agreement made the funding and implementation of the EBP unlike traditional water quality projects. For example, under this project, only the most obvious water quality risks were addressed, which provided a very cost effective approach to improving water quality. In more traditional water quality projects, each of the identified water quality risks must be addressed before the project is considered completed.

Rohe Farm

Lessons learned at the Rohe Farm were largely positive. The cooperation of the manager/owner led to the adoption of additional initiatives on the farm, including rotational grazing. This was not included in the original EBP plan due to the need to focus on higher priority problems of manure and barnyard management.

Better coordination with the Onondaga County Soil and Water Conservation District (OCSWCD) may have helped the Rohe Farm qualify earlier for additional services. The District had assumed that our planning process extended to BMP for field practices such as nutrient management planning and erosion control. However, the EBP was designed to focus on farmstead sources of nutrient pollution to Harbor Brook. Since improving our communication with the OCSWCD, the Rohes are now scheduled to have a nutrient management plan developed through the District in the next two years.

At a review meeting of EBP progress in November 2000, the possibility of involving the OCSWCD in the maintenance and operation of the project was discussed. District technicians have an ongoing relationship with the farms in the county and will likely interact with the farmers on a continual basis over a course of many years.

It is unlikely that District technicians would have been able to provide extensive background research, alternative strategies, engineering design and reporting in the time allotted this project due to District staff constraints. However, they are capable of integrating the privately implemented improvements into their "Whole Farm Approach" for future District activities with

that particular farm.

Greater coordination between the EBP project team and the OCSWCD occurred after the November 2000 meeting. Project information has been shared with OCSWCD staff for purposes of assisting cooperating farms on various District-led projects including whole-farm planning, nutrient management planning and permit assistance for the Confined Animal Feeding Operation (CAFO) program. The District has been better able to perform need assessments and plan additional services for these farms. The groundwork has been laid for further collaboration on water quality protection projects in the Onondaga Lake watershed. A preliminary agreement has been reached for partnering efforts on the proposed EBP project extension.

Future improvements at the Rohe Farm may include:

1. Nutrient management plan - this practice would assist the farm in managing its nutrient inputs, outputs and cycling on the fields. Application of nutrients in the form of manure and compost, when done at balanced and budgeted rates, would help to prevent the transport of nutrients such as phosphorus and nitrogen into surface waters of the Onondaga Lake watershed.

2. Manure and farm waste storage/composting area - this practice would allow a more accessible location to store and/or compost manure, spent bark and waste feed from the improved barnyard area, new manure basin and the existing manure handling shed. During winter months and wet, muddy field conditions, raw manure could be stored until field conditions are more favorable.

3. Oil-free vacuum pump - installation of this type of pump would eliminate the drip of oil into rainwater collection from barn roof.

8.1.2 Guptill Farm

The Guptill Farm provided lessons learned with regards to BMP planning, implementation and management on a farm that is undergoing a shift in business approach. The Guptill Farm was known to be changing in some aspects when the project was initiated, and represented a relatively common scenario in area farms; a recently retired dairy farm was being adapted to other farm activities including raising beef cattle, boarding heifers, raising feed crops, composting and market farming. At the same time, the farm was transitioning to organic farming and represented a greater sensitivity to the environmental impact of the farm operation. This translated into greater receptivity to changes in management practices on the farm that would lead to water quality improvements.

The first set of proposals was readily accepted with good feedback on the design of BMPs that

would lead to improvements in reducing runoff while improving the efficiency of animal movement and feeding and cleaning of high traffic areas. An adjustment was made in the water supply to animals on the feeding pad and in rotational grazing paddocks. The modified water supply would allow the animals to be excluded from the stream and riparian area, thereby reducing streambank erosion and direct nutrient inputs. Further, the feeding area was to be relocated from a terrace near the stream to an impervious surface several hundred feet from the stream.

Originally the plan included the development of an onsite spring to supply the water to the animals, a common BMP in this scenario. It was learned that the Town of Onondaga would be installing a municipal drinking water supply line on the roadside edge of one boundary of the farm. It was determined that investing in the construction of a supply line from the municipal source would provide a more reliable source of water to the feeding pad and new grazing paddocks. This increased the BMP item cost by approximately $4,000 or about 50%. The farmer agreed to match $2,000 of this additional cost since the municipal water supply would benefit the farm in multiple ways, including flexibility in future options in managing livestock, the compost site and other farm activities. The end result of the flexibility was a solution that met the farmer's needs and adequately met the BMP requirements and gave greater future options to the farm owner.

Another lesson learned is related to design of the feeding pad. The impervious surface met the needs of eliminating soil erosion from heavy animal traffic, controlling runoff to the bark filter and facilitating equipment operation for feeding and cleaning. The feeding pad was not covered with a roof and therefore the feed trough was occasionally saturated during heavy rains. A small roof or single pitched cover could prevent feed loss and even reduce the amount of nutrients in runoff by eliminating leaching of nutrients from the feed. If the roof was limited to the area of the feed trough, it could be constructed inexpensively and not restrict the access of equipment. The Guptill Farm ultimately intends to construct this improvement as time and resources become available.

Future improvements at the Guptill Farm may include:

Nutrient management plan - this practice would assist the farm in managing its nutrient inputs, outputs and cycling on the fields. Application of nutrients in the form of manure and compost, when done at balanced and budgeted rates, would help to prevent the transport of nutrients such as phosphorus and nitrogen, into surface waters of the Onondaga Lake watershed.

2. Manure and farm waste storage/composting area - this practice would allow a more accessible location to store and/or compost manure, spent bark and waste feed from the newly constructed barnyard and the existing freestall barn. During winter months and

wet, muddy field conditions, raw manure could be stored until field conditions are more favorable.

8.1.3 Leubner

The Leubner Farm presented the most challenging tasks in several respects. First, the layout of the farm was the most complex, with drainage pipes, water and waste sources coming from a series of locations and a large volume of polluted runoff leaving the farmstead. The management structure of the Leubner Family Farm was also unique with Fred Leubner as elder and primary decision-maker. Four children were also managing farm operations and making decisions on farm improvements. The timing of the EBP coincided with a major expansion of the milking herd on the farm. A modern milking parlor was built as well as a 400-head freestall and 60-stall hospital. These modifications and management changes in farm labor were a large investment of time and money for the Leubner Family. At the same time, there were areas related to manure and feed management that did not receive adequate attention and were liabilities to the farm, including nutrient and solids loading to a roadside ditch, aesthetics and runoff.

The project field team identified the various point locations for nutrients, direction and quantities of flows and methods for diverting clean water from mixing with process water. The lack of a detailed farmstead map including underground pipes and drainage tile necessitated the formation of a new map, much like the other farms in the EBP. However this map was considerably more structurally intensive, required numerous interviews with the Leubners, necessitated several revisions and took a large amount of time to produce. In the end, this effort was still inadequate as the information garnered incorrectly predicted the high volume of water that would flow into the designed treatment areas of the bark bed filters.

The failure of the field team to be consistently onsite during the initial phases of construction allowed for some practices to be constructed undersized and at the wrong location. Furthermore, a brief dry spell during construction misrepresented the amount of water that had been flowing before and after construction. Consequently, the bark filter beds were sized too small.

The operation and management of the bark filter beds in relation to the ongoing management of the manure-loading ramp was an additional issue. Runoff into the barn, infrequent barn cleaning and overloading of the manure spreader contributed to the overflow of the manure handling ramp and manure spreader at multiple locations. This was simply a continuation of the old practices with the newer structures. A draft operation and maintenance plan developed for the Leubners had not been shared with the family member who managed this portion of the farm operation.

Lessons learned in this case were:

- The value of identifying drainage patterns and remedial measures
- The need to provide continuous onsite construction inspection
- The importance of communication among the farm operators

Future improvements at the Leubner Farm may include:

Concrete stabilization with concrete around manure pumpout locations for veal calf barn and dairy cow freestall barn.

2. High strength silage leachate storage - this practice would intercept silage leachate from bunk silo before it enters the bark filter and vegetative filter strip. The leachate could then be applied to fields, thus diluting its impact on vegetation. This storage could be combined with manure storage from the freestall barn where the milking cows are kept.

3. Manure and farm waste storage/composting area - this practice would allow a more accessible location to store and/or compost manure, spent bark and waste feed from barnyard areas and the existing heifer barns. During winter months and wet, muddy field conditions, raw manure could be stored until field conditions are more favorable.

4. Nutrient management plan - this practice would assist the farm in managing its nutrient inputs, outputs and cycling on the fields. Application of nutrients in the form of manure and compost, when done at balanced and budgeted rates, would help to prevent the transport of nutrients such as phosphorus and nitrogen into surface waters of the Onondaga Lake watershed.

8.2 Urban BMPs

8.2.1 Stormwater Vortex Unit

The Downstream Defender® worked as expected; it was easy to maintain, it collected coarse, medium and fine-sized grit and trash. Nutrient reductions were relatively low, most likely due to low influent nutrient concentrations. Maintenance is key to the successful operation of such equipment because once the unit's sediment storage sump is full, a reduction in removal efficacy is possible due to the increased risk of re-entrainment of solids deposited within the zone above the shielded sediment storage sump. Ideally a six-foot diameter unit should have been installed; however due to budget constraints and sampling objectives, as described in Section 4.3.1, a four-foot diameter Downstream Defender® was purchased and installed. Regardless of the size of the

unit, site-specific conditions should be evaluated based on the maximum depth of excavation or depth of unit. If a larger (i.e., deeper) sump can be installed, this would increase the volume for solids storage and therefore reduce the amount of maintenance or clean-out trips. A cost analysis should be performed comparing the expense of deepening the sump versus the outlay incurred by additional maintenance time.

Vegetative Filter Strip

The vegetative filter strip generally worked as expected; it was easy to maintain and it absorbed much of the runoff from the parking lot. However, the export of nutrients was unexpected. This was likely apparent because of the very low concentration of nutrients influent to the vegetative strip. It should be recognized that an importation of nutrients, through fertilizers or compost, is required to establish vegetation and these strips may have the potential to export nutrients once established. Trash control is also an important maintenance issue when dealing with the vegetative filter strips. They tend to collect trash within the vegetation quickly and can look unmaintained if trash collection is not performed on regular basis. The Burnet Park Zoo personnel regularly cleaned trash from the strip.

Siting a vegetative filter strip is challenging due to the size of the land required to provide adequate treatment. Retrofits of this treatment alternative may prove difficult, but new construction under the new stormwater regulations may find many advantages of this alternative including increasing green space and reducing stormwater volume through infiltration.

Sampling and Monitoring BMPs

8.3.1 Agricultural Sampling and Monitoring

In the agricultural setting, BMP effectiveness was evaluated by measuring water quality in the receiving water immediately downstream of the farmstead where the BMPs were implemented. In the case of the Rohe and Leubner farms, water quality samples were collected from intermittent streams. The flow regime of the stream can have a significant impact on how the pollutants are discharged into the watershed and how they should be measured. For example, it is likely that at the Rohe and Leubner farms pollutants moved from the farmstead into the intermittent streambed throughout the summer and fall (low to no flow scenario), and remained resident in the streambed adjacent to the farmstead until enough flow was present to convey the pollutants downstream. During major sustained rain events and the spring snowmelt period, the accumulated pollutant would become flushed from the streambed and carried down into the lower lying areas of the watershed. This in affect results in pulses of pollutants rather than a continuous source of pollutants. In terms of environmental sampling and monitoring the latter

(continuous source) is preferred because pollutant loads can be measured more accurately with routine sampling. In the case of non-continuous sources of pollutants, or pulses of pollutants, the relationship between flow and pollutant flushing most be understood, and a sampling and monitoring program most be designed to capture a range of flow and pollutant flushing scenarios. The original sampling and monitoring program for this project included routine sampling once per month; however, based on the flow regimes at the Rohe and Leubner farms it was changed to sample wet-weather events on a once per month frequency and more frequently sampling during the spring runoff period and.

8.3.2 Urban Sampling and Monitoring

In the urban setting, specifically with regards to the stormwater vortex unit, measuring solids presented challenges in terms of both sampling and laboratory analysis.

The originally proposed sampling procedure relied on the use of a submersible pump to draw stormwater from the sewer to the street level where sample bottles could be filled. When selecting the pump, factors such as pumping power and transport velocity were considered. It is important that the pumping power provide a transport velocity sufficient enough to keep solids in suspension, otherwise the solids in the stormwater will not be drawn with the water to the sampling location. An additional concern with pumping stormwater for the purpose of solids sampling is the issue of solids maceration; submersible pumps can break large solids apart and bias the analytical results. After discussions with the stormwater vortex manufacturer, it was decided not to use the pumps, but instead use a US DH-81A sampler, which was specifically designed for sampling sediment in flowing water. A photo of the US DH-81A sampler is illustrated in Figure 39.

The US DH-81A sampler was used during the first five events, but concerns developed regarding the representativeness of the samples. The US DH-81A sampler is essentially a sample bottle with a specially designed nozzle that allows the bottle to be oriented in a horizontal position without losing the sample. Both the bottom of the sample bottle and the nozzle create increased flow pressure, which results in water flowing around the sample bottle and not into the bottle. As a result of the concern that the US DH-81A sampler was not taking representative samples of the sediment load, a Van Dorn sampler was used to sample during the last event. The Van Dorn sampler is illustrated in Figure 40.

The Van Dorn sampler is essentially an open tube that has two end caps that can close instantaneously. When using in a storm sewer, the end caps are in the opened position allowing water to flow freely through the tube. The end caps are then closed, trapping a sample of water within the tube. This appears to have an advantage over a sample bottle because significant pressure increases are not induced. In comparison to the submersible sampling pumps, transport velocity and solids maceration are no longer issues.

The originally proposed solids analysis was Total Suspended Solids (USEPA 160.3). However this analysis was changed to reflect the industry's new understanding of laboratory bias (USGS, 2000) with respect to heavy solids and the TSS analysis. In general, the original TSS analysis allowed the laboratory to spilt the primary sample for the purpose of performing the analysis with a single filter of size 24 or 42 mm. Research has shown that splitting stormwater samples with heavy solids can bias the TSS results downward by as much 50% (USGS, 2000). The new TSS method (also know as ASTM 3977 Suspended Sediment Concentration) required the laboratory to filter the entire sample and not take a split or sub-sample. It appears that the ASTM 3977 Suspended Sediment Concentration has an advantage over the USEPA 160.3 Total Suspended Solids method because it eliminates sampling splitting; in general the less a sample is handled and manipulated the more representative it is. Because federal and state effluent discharge permits are written to include USEPA 160.3 Total Suspended Solids, both of these analyses should be run simultaneously until enough data are collected to the presence or absence of laboratory bias.

9 TRANSITION FROM ROUND 1 TO ROUND 2

The agricultural EBP sampling approach yielded data that provided only a first-order approximation of farmstead runoff before and after BMP implementation; prior to this sampling program there were no such site-specific data available for farmstead runoff available in Onondaga County. The sampling approach was consistent with budgetary constraints, which allotted 85% of the budget to BMP implementation and the remaining 15% to sampling and monitoring, laboratory analyses, data analyses, meetings and reporting.

At the conclusion of the first phase, it was agreed that there was a need for more site-specific water quality data. Therefore, a second phase of the EBP is being implemented. These separate phases will herein be referred to as Onondaga Lake Nonpoint Source Environmental Benefit Project Round 1 and Round 2. The purpose of Round 2 is to undertake additional monitoring in order to provide more substantial data from a lengthier monitoring period to better assess the effectiveness of the selected agricultural BMPs and their impact on water quality in the receiving waterbody. Round 2 is to be consistent and compatible with Round 1 and to be treated as an amendment to the previous work.

A major element of the work in Round 2 is to undertake additional monitoring of the types of agricultural BMPs implemented during Round 1 to provide more substantial data from a longer monitoring period in order to better assess the utility of the selected agricultural BMPs and their impact on water quality in the receiving water body. The proposed monitoring and sampling period is a full two years. This two-year period does not include the construction period, which may take three additional months.

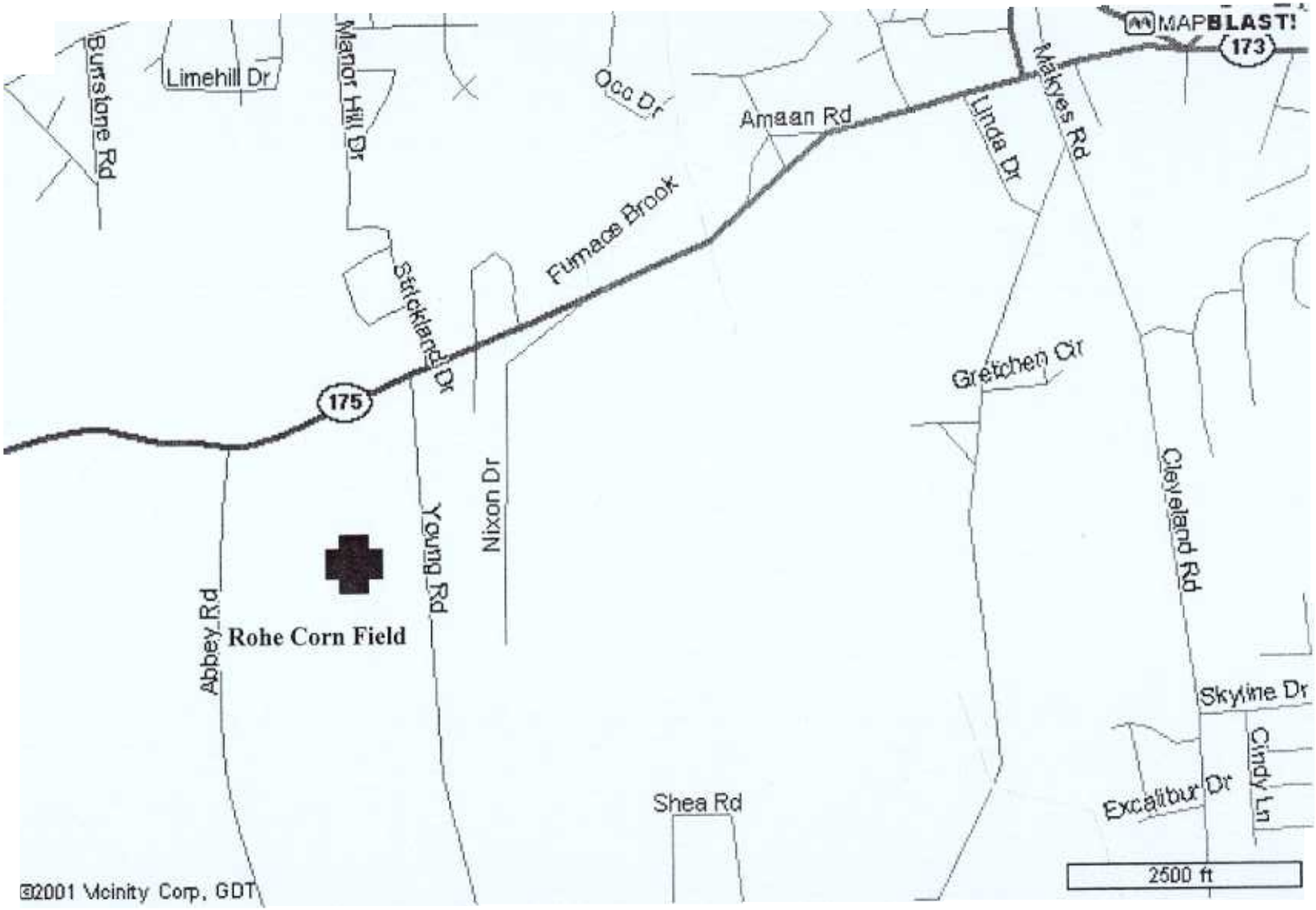
Monitoring and sampling will be performed on structural and soil management BMPs used for controlling or preventing nutrient-laden runoff from agricultural practices. Whereas the structural BMPs are physical structures such as implemented in Round 1, soil management BMPs are operational practices pertaining to crop field management to reduce nutrient runoff (for example, modifying the timing and amount of manure application).

Two farms are being considered for the additional monitoring and sampling effort, the Rohe Farm and the Bloom Farm. The Rohe Farm participated in Round 1 and the OCSWCD recommended the Bloom Farm as a location to sample a bark filter system used to treat milk parlor waste. The location of these farms is shown in Figures 93 and 94.

Monitoring and sampling at the Rohe Farm will include both structural and soil management BMPs while monitoring and sampling at the Bloom Farm will include only structural BMPs. At the Rohe Farm, a 20-acre cornfield will be divided into two equal 10-acre plots. One plot will be managed as is currently practiced and the other plot will be managed per recommendations from

the OCSWCD with respect to manure and fertilizer applications. Tile drain will be installed in these plots for the purpose of monitoring and sampling water quality. The outlet of these tile drains will not discharge directly into the creek as is typical but rather discharge into a bark filter or vegetative filter strip for treatment. The bark filter or vegetative swale will be monitored and sampled as a structural BMP. At the Bloom Farm a milk parlor treatment system recently constructed by the OCSWCD, consisting of a solids separation tank and bark filter, will be monitored and sampled. The bark filter at the Bloom Farm is a subsurface system; it receives flow from drain tile that are installed within the bark media. This differs from the bark filters that were installed as part of Round 1, which were hydraulically loaded from the surface. The function of the Round 1 surface bark filters was to trap solids on top of the bark media and provide some treatment of the runoff resident in the bark media. The intent of the subsurface bark filter is to percolate water into the ground and provide some treatment of the water resident in the bark media.

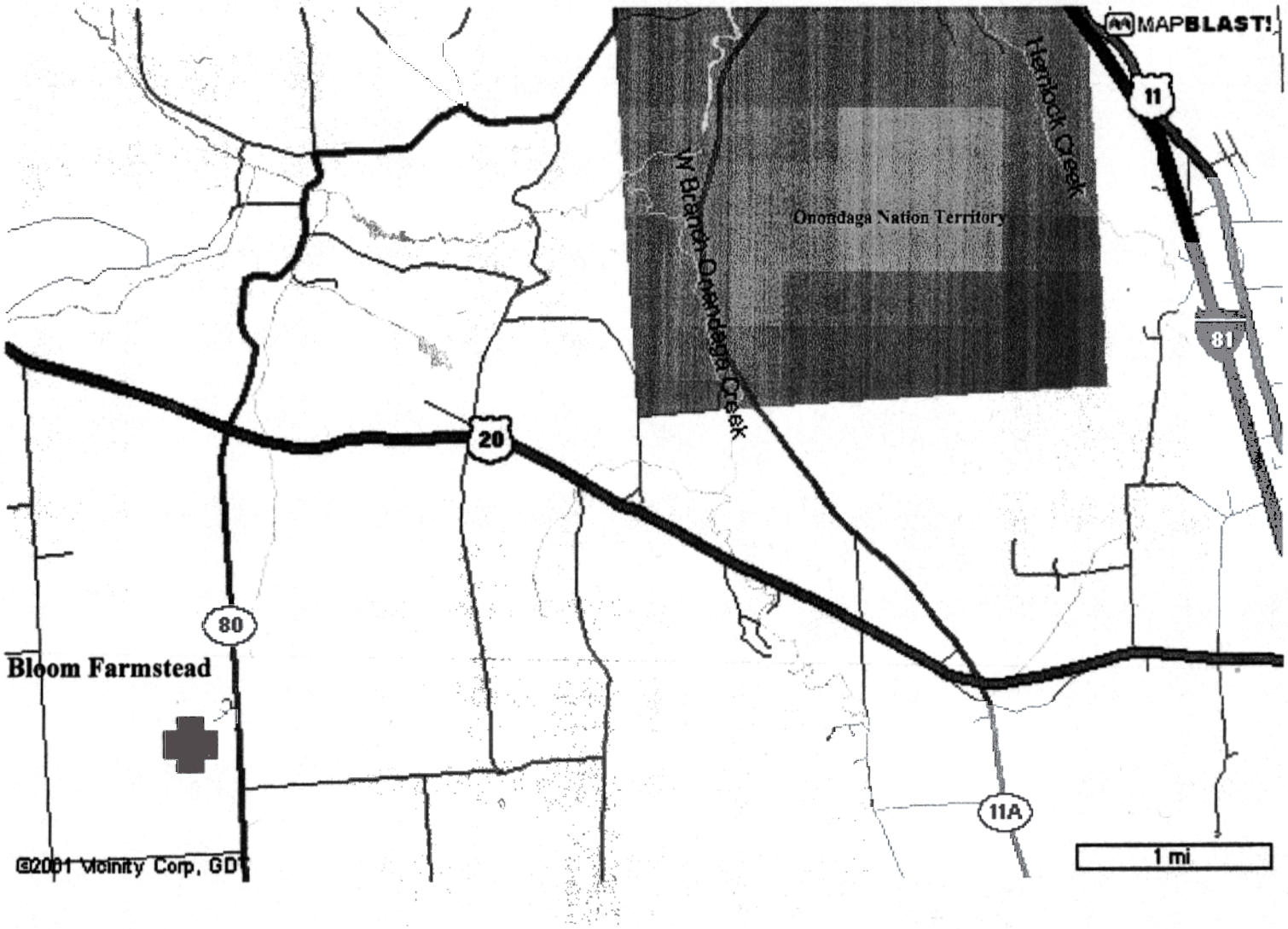
The project is proposed to begin in the spring of 2002 with approximately three months of construction. Once the construction is complete, two full years of monitoring and sampling will be undertaken. It is anticipated that two years will provide ample time and rainfall to sample nine wet-weather events.



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Rohe Farm Location

Figure 91



Moffa & Associates
A unit of Brown and Caldwell

Onondaga Lake Watershed, Nonpoint Source EBP
Bloom Farm Location

Figure 92

10 CONCLUSIONS

10.1 Agricultural BMPs

The farmsteads appear to be a genuine source of nutrient pollution that can be practically removed from the Onondaga Lake watershed in terms of quantity and cost effectiveness.

Improvements in manure handling and animal-pasturing practices provide a significant reduction in nitrogen and phosphorus loadings to receiving waters. Re-engineering existing practices and providing training in the new practices to the farmer lead to such improvements.

Creating buffer zones between the receiving waters and active livestock areas and manure handling stations provide a significant reduction in nitrogen and phosphorus loadings to receiving waters. Creating buffer zones require less structural amenities than manure handling station improvements, thus cost less.

Based on the three farms studied during this project, using first-order approximations, total phosphorus and TKN reductions as a result of BMP implementation ranged from 400 to 1,000 pounds and 900 to 8,200 pounds, respectively. Percent removals ranged from 55% to 70% for total phosphorus and 50% to 79% for TKN.

Potential nutrient reductions from the other 50 farms in the Onondaga Lake watershed without BMPs equate to approximately 20,000 to 50,000 pounds per year of total phosphorus reduction and approximately 45,000 to 410,000 pounds per year of TKN reduction. Assuming that 50% of the TKN is ammonia-N, than there is approximately 22,500 to 205,000 pounds per year of potential ammonia-N reduction. As a frame of reference, based on current Metropolitan Sewage Treatment Plant (METRO) upgrade plans, the potential total phosphorus reduction at METRO is 66,500 pounds per year and the potential ammonia-N reduction is 550,000 pounds per year.

The cost of BMP construction and implementation on each farm was approximately $45,000. This equates to approximately $45 to $112 per pound of total phosphorus removed per year and $10 to $100 per pound of ammonia-N removed per year. It is important to note that these figures do not include cropland loads, which will be addressed in Round 2. As a frame of reference, Onondaga County is investing approximately $125 million (1997) at METRO for phosphorus and ammonia removal during the period from 1996 to 2015. This equates to approximately $1,900 per pound of total phosphorus removed per year and $230 per pound of ammonia per year.

It appears that removal of nutrients, in particular phosphorus, at the farmstead may be more cost effective than removal of nutrients at METRO, but several other factors, such as relative quantity

of nutrient, transformation and availability of phosphorus as it moves from the farmsteads to Onondaga Lake, proximity of pollutant source to Onondaga Lake, and longevity of BMPs should be considered.

10.2 Urban BMPs

The costs of the urban stormwater vortex unit and vegetative filter strip were $34,000 and $6,000, respectively. The cost difference reflects the degree of capital improvements involved.

The urban BMPs were effective at removing solids from stormwater, but not at removing nutrients. This is likely due to the low concentration of nutrients influent to these BMPs. This may suggest that in certain urban environments, such as parking lots and city streets, nutrient runoff is not a priority pollutant.

The stormwater vortex unit worked as expected; it was easy to maintain and it collected coarse, medium and fine sized grit (4.75 mm to .075 mm) and trash. The stormwater vortex unit removed approximately 0.14 cubic feet and 6 lbs of material per 1,000 gallons of stormwater processed. The water quality-sampling program had limitations because the original sampling equipment and laboratory analysis were not appropriate for stormwater with coarse and medium sized grit content (> 0.15 mm).

The vegetative filter strip generally worked as expected; it was easy to maintain and it absorbed much of the runoff from the parking lot. However, it was a source (i.e., exporter) of nutrients. The source of the nutrients was likely the compost used to fertilize and establish vegetation. In light of the fact that the effluent nutrient concentrations were low as compared local receiving water concentrations, the increase in nutrients from influent to effluent was likely apparent because of the very low influent concentrations. The vegetative filter strip, which was approximately 150 square yards could absorb approximately 1.0 inch of rain before runoff exceeded its infiltration capacity.

11 RECOMMENDATIONS

11.1 Agricultural BMPs

County agencies should continue funding BMP implementation on agricultural lands. Communication between county agencies such as the Soil and Water Conservation District and the Department of Water Environment Protection is critical to coordinate these future efforts and insure their success.

The most significant first steps that can be completed on a farm relate to abatement of point sources originating from manure handling and pasturing practices. However, a Whole Plan Farm, which assesses all point and nonpoint water quality risks should be completed.

Water quality data collection was limited due to the scope of work. To improve upon this sampling approach, a multiyear program could be implemented to increase the probability of comparative pre- and post-sampling years. Additionally, for an improved water quality-monitoring program, farm setting and hydrologic relief should be set as a priority.

Additional work to project watershed benefits from agricultural BMP implementation should be completed. This work may include monitoring and sampling before and after BMP implementation for a long duration of time. This work may also include monitoring and sampling as well modeling to better understand the fate of the phosphorus as it moves from the upper reaches of the watershed into Onondaga Lake.

11.2 Urban BMPs

Stormwater vortex units should be installed at selected points in the urban setting to capture solids and trash. Nutrient capture may be limited due to the relatively low concentrations in the runoff from parking lots and city streets.

Consideration should be given to maximizing the size of vortex sediment storage sump to maximize storage and thereby reduce maintenance frequency. A cost analysis should be performed comparing the expense of deepening the sump versus the costs incurred by additional maintenance time.

Retrofitting a vegetative filter strip into an existing urban setting may prove difficult to site. However, constructing strips in new developments may provide many advantages including increasing green space and reducing stormwater volume through infiltration.

Measuring solids in stormwater samples presented some challenges both in terms of sampling

and in analytical procedures. In the future, when heavy solids in stormwater are an issue it is recommended that a volume sampler (e.g. Van Dorn sampler) be used. Analytical procedures should also be appropriate to quantify the heavy solids.

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Appendix A

Rohe Design Drawings

CONTRACT DRAWINGS

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

ROHE FARM
ONONDAGA COUNTY, NEW YORK

CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT
BOARD

INDEX OF SHEETS:

TITLE SHEET: EXISTING SITE LAYOUT

SHEET 1: LOCATION OF BEST MNGMT. PRACTICES
SHEET 2: CONST. DETAILS CONC. PVMT. & CATCH BASIN
SHEET 3: CONSTRUCTION DETAILS 8" DRAIN & LEVEL SPREADER
SHEET 4a: CONCRETE PAD & BUMP WALL DETAILS
SHEET 4b: TIMBER CURB & BARK FILTER DETAILS
SHEET 5: STABILIZED ACCESS ROAD DETAILS
SHEET 6: MANURE HANDLING AREA DETAILS
SHEET 7: 6"ø DRAIN PIPE AND GUTTER DETAILS
SHEET 8: VEGETATION PLAN & NEW FENCE LAYOUT

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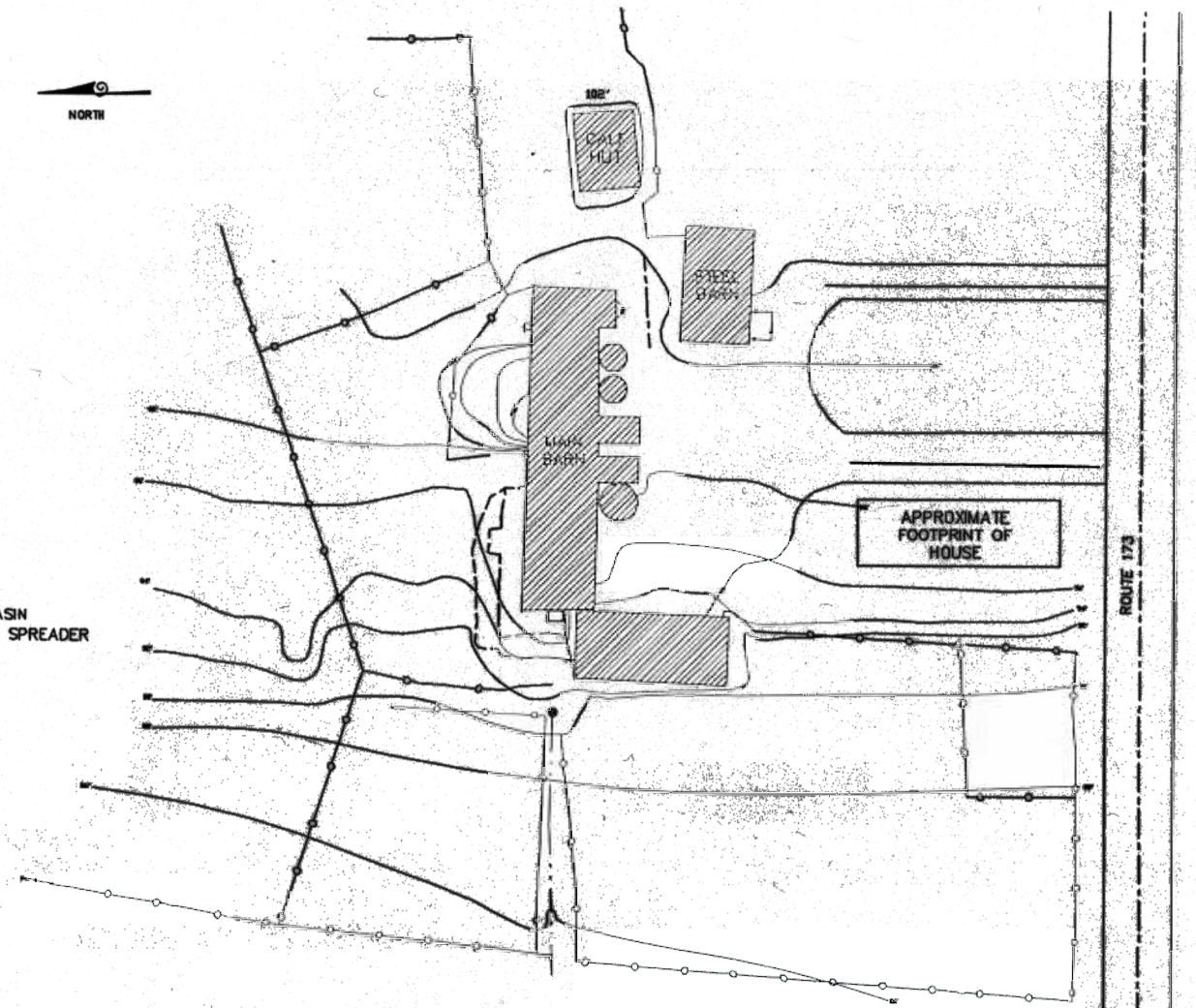
SYRACUSE, NY 13214
PHONE: (315) 446-3010
FAX: (315) 446-0443



EXISTING SITE LAYOUT

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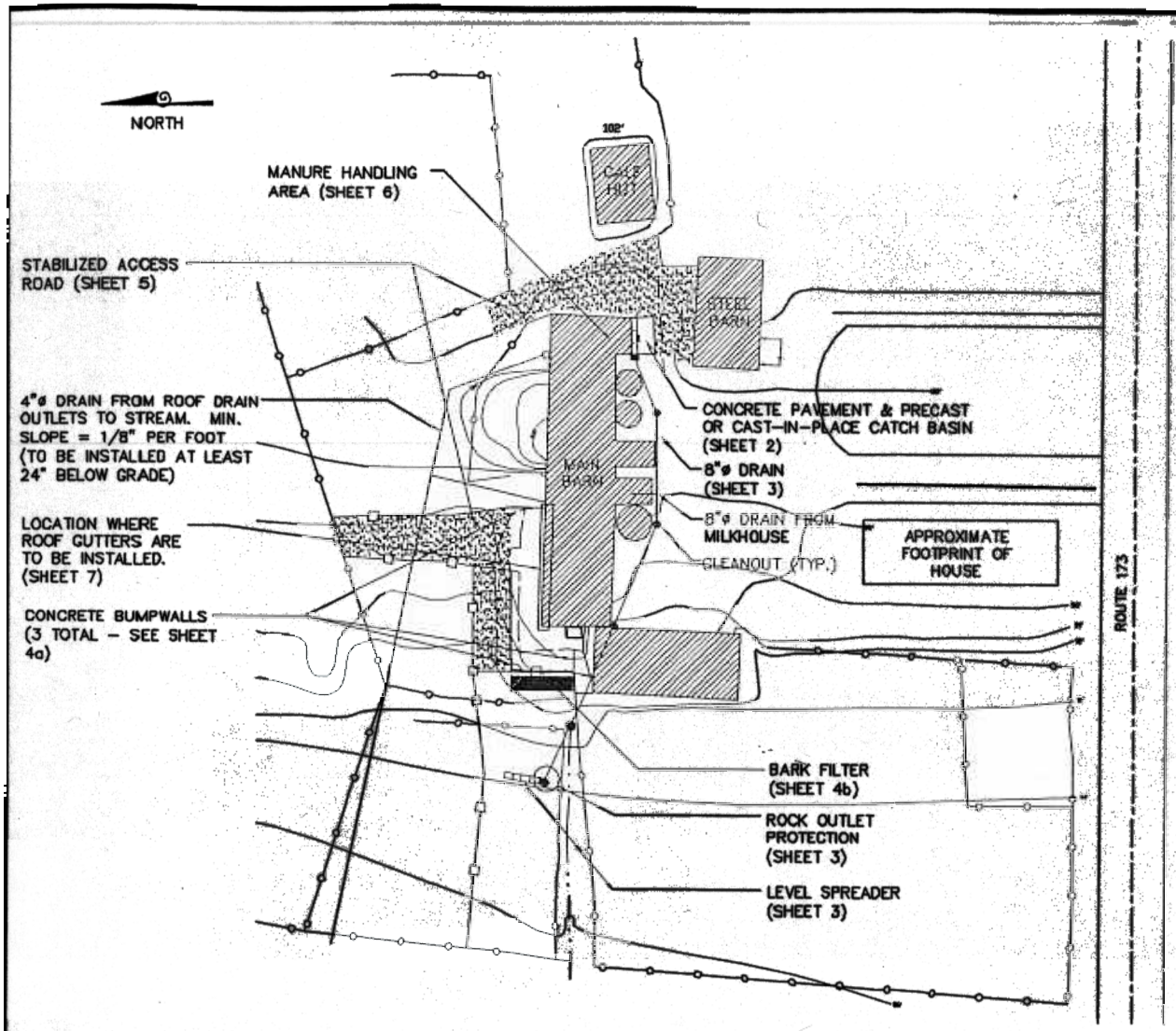

LEGEND

EXIST. FENCE

NEW FENCE (TO BE INSTALLED)

GENERAL NOTES:

All surfaces to be restored to original condition by contractor.

SCALE IN FEET

0 30 60 90 120 150

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		DATE:	12/21/00
		DRAWN BY:	TJB
		CHECKED BY:	ML
		SCALE:	AS SHOWN
		FILENAME:	ROHE_MAP.DWG

MOFFA & ASSOCIATES
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6710 COMMONS PARK
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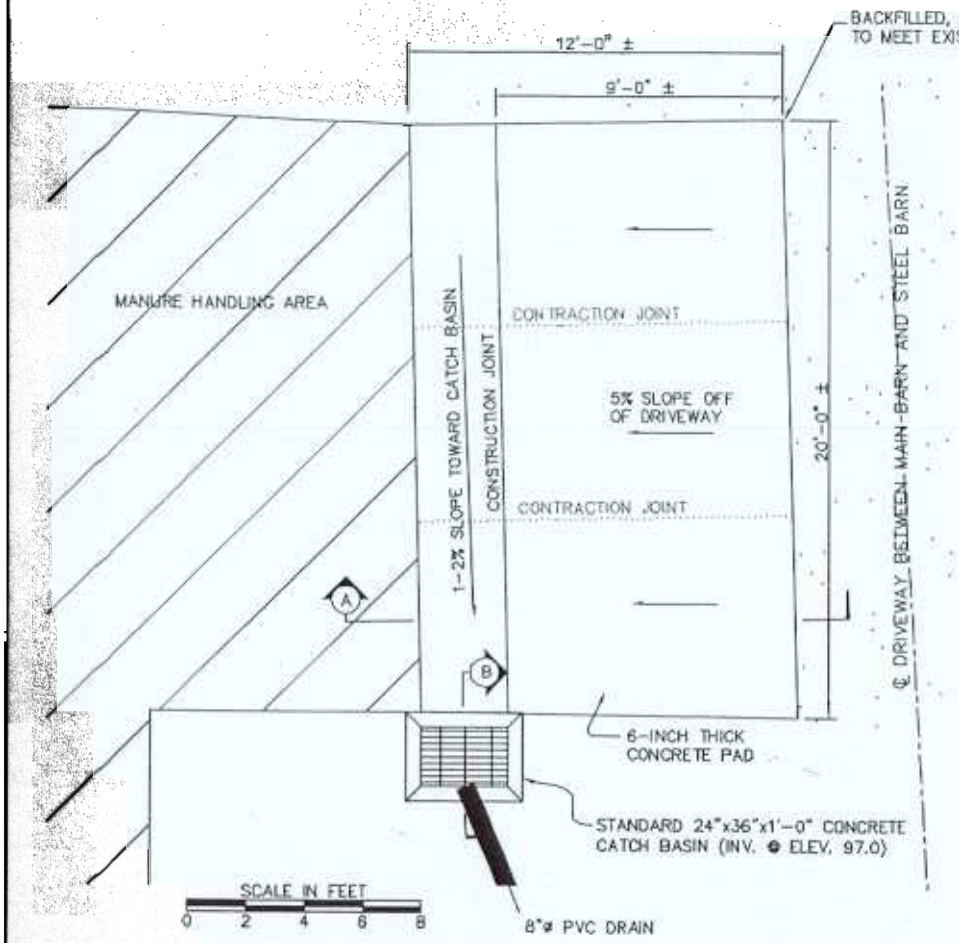
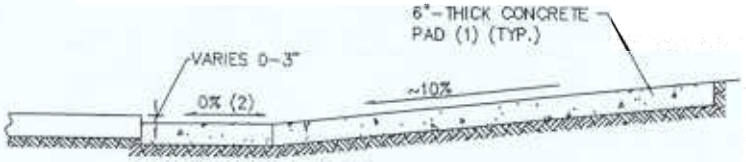
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

LAYOUT OF BEST MNGMT. PRACTICES
ROHE FARM
ONONDAGA COUNTY, NEW YORK

1



MANURE HANDLING ENTRANCE PAD & CATCH BASIN



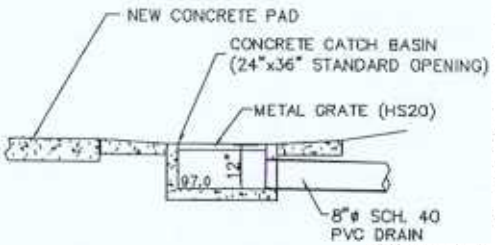
SECTION A - NEW CONCRETE PAD

NOTES:

1. USE 4000 PSI CONCRETE (ASTM C150) WITH 6"x6"-W1.4xW1.4 WELDED WIRE FABRIC (ASTM A185). CONCRETE TO BE POURED AT 3-1/2" SLUMP.

2. THIS SECTION OF PAD SLOPED APPROXIMATELY 1¼% TOWARD CATCH BASIN.

3. COMPACTION UNDER PAD: USE 6" LIFTS WHERE FILL REQUIRED, COMPACT USING THREE (3) PASSES OF A 2,500-LB. IMPACT FORCE VIBRATORY TAMPER.



SECTION B - CATCH BASIN

NOTES:

1. CONCRETE CATCH BASIN TO CONFORM TO REQUIRED SPECIFICATION FOR HS20 LOADING.

2. PVC CATCHBASIN CONNECTION TO CONFORM TO ASTM C923.

1	ADD'L SPECIAL AND DESIGN CHANGES	4/26/00	

PROJECT NO.:
DATE: 03/31/00
DRAWN BY: TAS
CHECKED BY: JAL
SCALE: AS SHOWN
FILENAME: ROHE_MAP-2100

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
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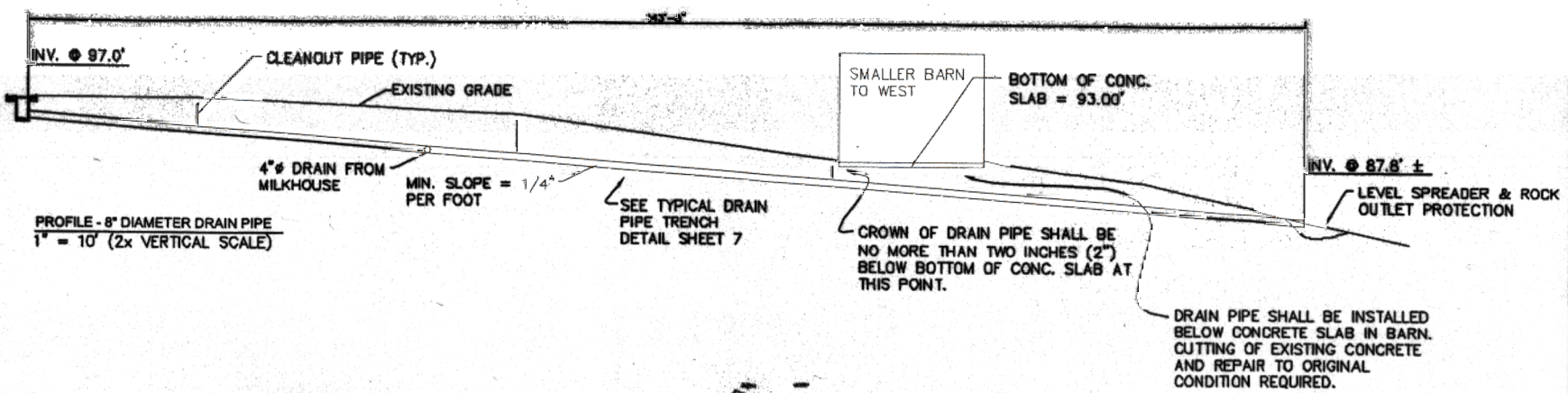
FAX: (315) 446-0443

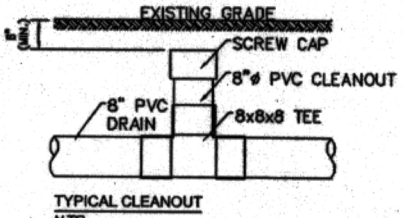
PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
CONST. DETAILS CONC. PVMT. & CATCH BASIN
ROHE FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
2

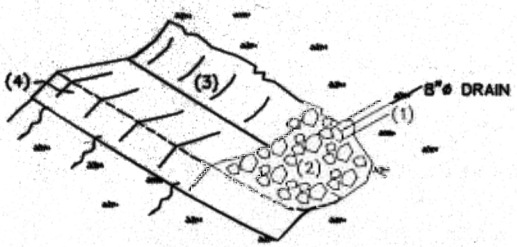


PROFILE - 8" DIAMETER DRAIN PIPE
1" = 10' (2x VERTICAL SCALE)



TYPICAL CLEANOUT
NTS

NOTES:
1. ALL PIPE SCH. 40 PVC



LEVEL SPREADER DETAIL

NOTES
1. INVERT ELEV. OF DRAIN AT OUTLET = 87.8' (ACTUAL ELEVATION MAY VARY BY NO MORE THAN TWO FEET)

2. ROCK OUTLET PROTECTION – 18" LAYER OF 9" TO 12" DIA. FIELD STONES. APPROX. 5 FEET LONG BY 5 FEET WIDE, 6" BELOW INVERT OF PIPE OUTLET.

3. LEVEL SPREADER DIMENSIONS (FINAL DIMENSIONS AFTER TOPSOILING AND REVEGETATION): 20 FT. LONG, BY FIVE FEET WIDE, BY SIX INCHES DEEP. TO BE CUT INTO ORIGINAL GROUND (NOT FILL).

4. MATTING SHOULD BE A MINIMUM OF 4 FT. WIDE EXTENDING 6 INCHES OVER THE LIP AND BURIED 6 INCHES DEEP IN A VERTICAL TRENCH ALONG THE INSIDE EDGE. THE OUTSIDE EDGE SHOULD BUTT AGAINST SMOOTHLY CUT SOD AND SHOULD BE SECURELY HELD IN PLACE WITH CLOSELY SPACED WIRE STAPLES AT LEAST 12" IN LENGTH. MATTING SHALL BE BURLAP OR EQUIVALENT WITH SUFFICIENT OPENINGS TO ALLOW GRASSES TO PENETRATE.

5. ENSURE THAT THE LIP IS LEVEL (I.E. SAME ELEVATION ALONG ENTIRE LENGTH) TO UNIFORMLY SPREAD DISCHARGE.

6. RETOPSOIL (WHERE NEEDED), SEED AND MULCH THE DISTURBED AREA IMMEDIATELY AFTER CONSTRUCTION, AS SPECIFIED.

7. TOPSOIL & SEED TO BE FIRMED WITH 1 PASS OF A 100 LB. ROLLER.

8. 20' OF 8"ø FLEXIBLE PIPE SHALL BE CONNECTED TO DRAIN OUTLET TO DIVERT WATER AWAY FROM LEVEL LIP SPREADER WHILE VEGETATION IS ESTABLISHED. FLEXIBLE PIPE TO BE FURNISHED AND INSTALLED BY CONTRACTOR.

1	ADDL. SPECS. AND DESIGN CHANGES	4/28/00

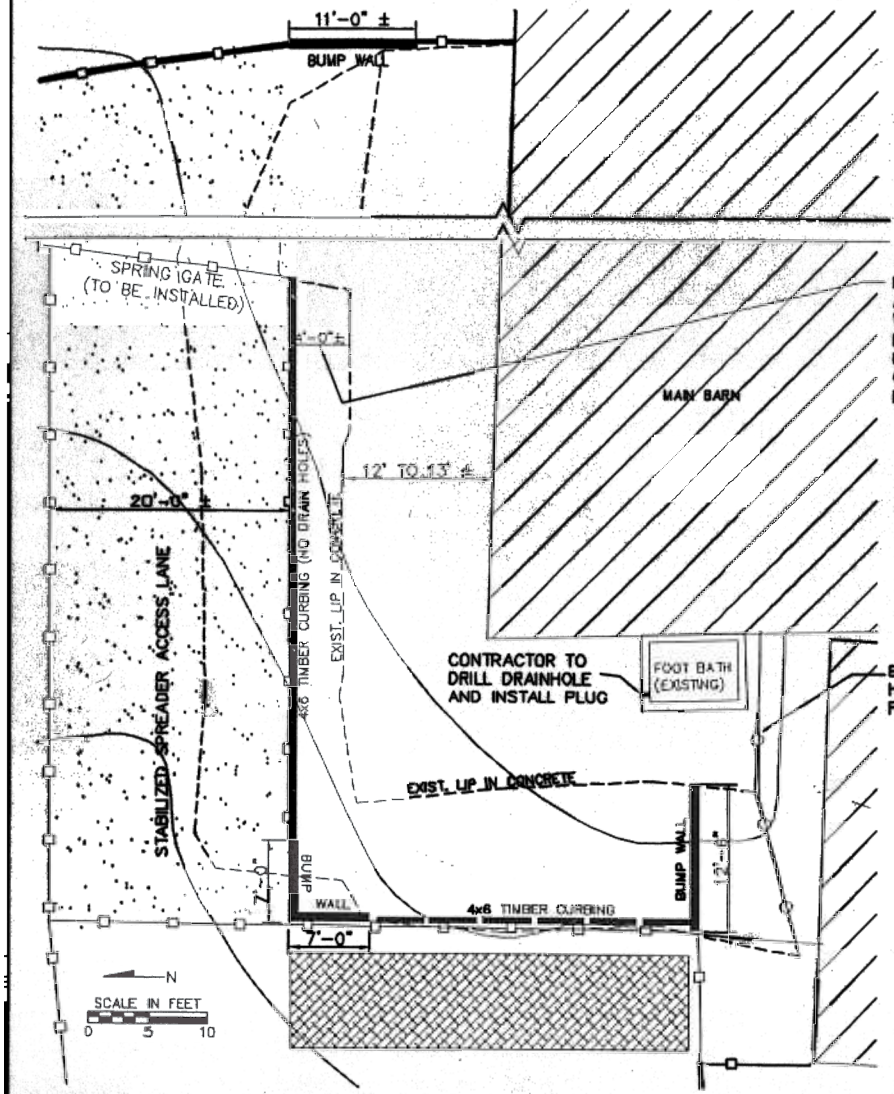
PROJECT NO.:
DATE: 03/31/00
DRAWN BY: TAB
CHECKED BY: JAL
SCALE: AS SHOWN
FILENAME: ROHE MAP.DWG

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
3710 COMMONS PARK
P.O. BOX 28
SYRACUSE, NY 13214
PHONE: (315) 446-3010
FAX: (315) 446-9443

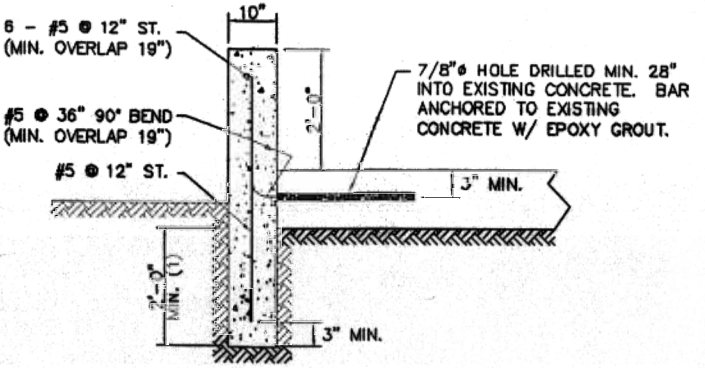
PROJECT TITLE:
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE:
CONSTRUCTION DETAILS 8" DRAIN & LEVEL SPREADER
ROHE FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
3



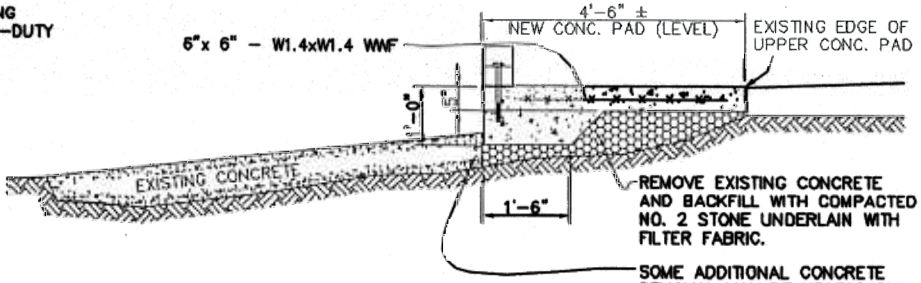
REMOVE EXISTING CONCRETE AND POUR NEW PAD FLUSH WITH EXISTING UPPER PAD MINIMUM 6" THICK. (TYPICAL FROM EAST END OF PAD TO CORNER BUMPWALL AT WEST END – APPROX. 80 FEET)



TYPICAL SECTION – BUMP WALL

NOTES:

1. DEPTH OF WALL BELOW GRADE GREATER THAN OR EQUAL TO HEIGHT OF WALL ABOVE GRADE.
2. USE 4000 PSI CONCRETE (ASTM C150) POURED AT 3–1/2" SLUMP.
3. ALL STEEL ASTM A615 – A617



TYPICAL SECTION – NEW CONCRETE PAD

NOTES:

1. USE 4000 PSI CONCRETE POURED AT 3 1/2" SLUMP.
2. FILL USING 6" LIFTS COMPACTED WITH THREE (3) PASSES OF 2,500 LB. IMPACT FORCE VIBRATORY TAMPER.

1	ADD'L SPECS. AND DESIGN CHANGES	4/27/00

PROJECT NO.:
DATE: 05/31/00
DRAWN BY: TAS
CHECKED BY: JAL
SCALE: AS SHOWN
FILENAME: ROHE_MAP.DWG

MOFFA & ASSOCIATES
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P.O. BOX 88
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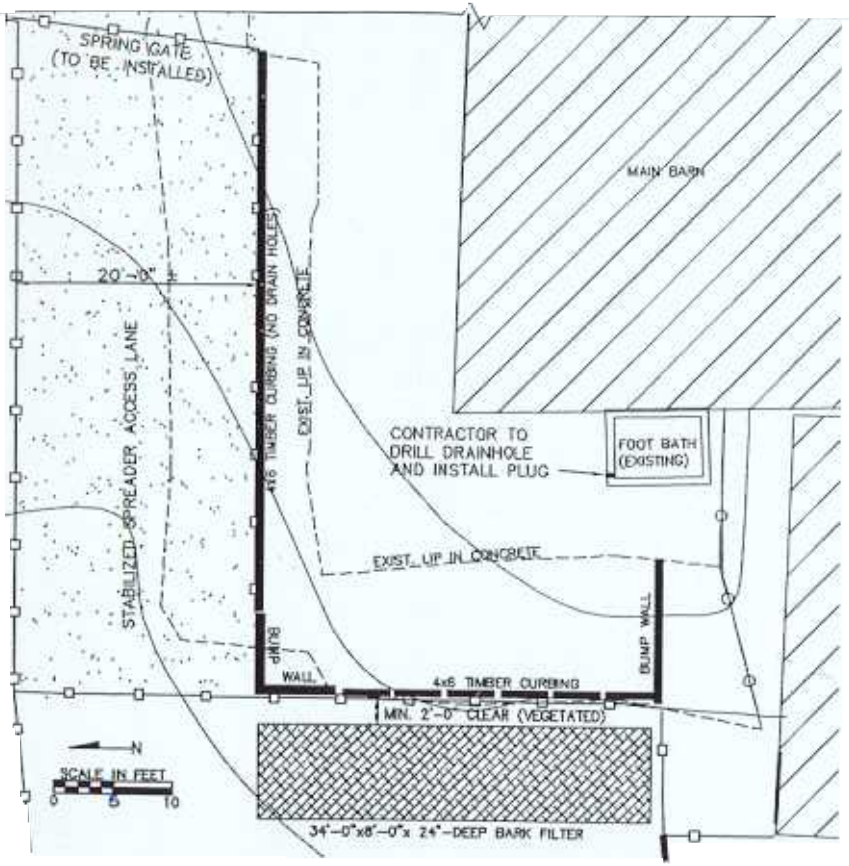
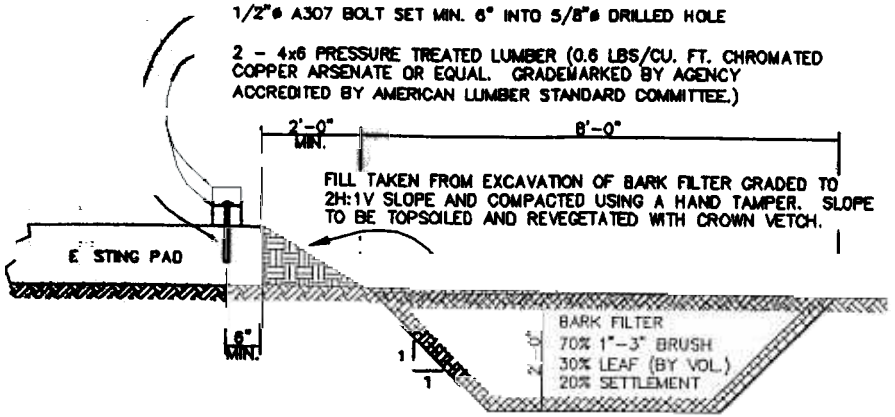
PHONE: (315) 445-2010
FAX: (315) 445-0443

PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

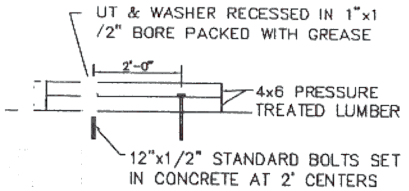
SHEET TITLE
CONCRETE PAD & BUMP WALL DETAILS
ROHE FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
4a



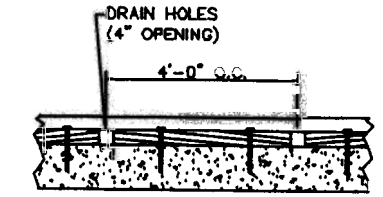


TYPICAL SECTION - TIMBER CURB & BARK FILTER



TYPICAL SECTION OF TIMBER CURB ASSEMBLY

HEIGHT OF CURB CAN BE VARIED BY ADDING AND NAILING 4x6 TIMBERS AS REQUIRED



TYPICAL SECTION TIMBER CURBING DRAIN HOLES

1	ADD'L REVISION AND DESIGN CHANGES	AMS	4/30/09

PROJECT NO.:
DATE: 03/31/09
DRAWN BY: TAS
CHECKED BY: JJL
SCALE: AS SHOWN
FILENAME: ROHE_MAP.DWG

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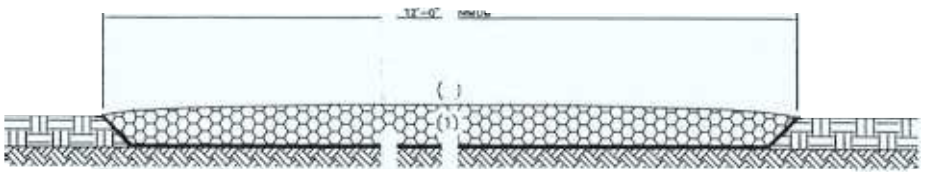
FAX: (315) 446-0443

PROJECT TITLE
ONON AGA AKE WATERSHED
NONPOINT SOURCE
ENVIR NMEI TAL BENEFIT PROJECT

SHEET TITLE
TIMBER CURB & BARK FILTER DETAILS
ROHE FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
4b



(3)

TYPICAL SECTION – STABILIZED ACCESS ROAD

NOTES:

1. ACCESS ROAD TO BE EXCAVATED DOWN TO EXISTING MINERAL SOIL, COVERED WITH 6 OZ. MUDGARD OR EQUAL, THEN COVERED WITH 8–10" LAYER OF COMPACTED NO. 2 STONE, ROCKDUST, OR APPROVED EQUIVALENT. FILL WITH TWO 4–5" LIFTS, COMPACTED WITH THREE PASSES OF 72–84" VIBRATORY MECHANICAL ROLLER.

2. TOP SURFACE OF ROAD SHALL BE SLIGHTLY CROWNED TO FACILITATE DRAINAGE.

1	ADD'L SPECS. AND DESIGN CHANGES	4/26/05

PROJECT NO.:
DATE: 03/31/00
DRAWN BY: DB
CHECKED BY: JL
SCALE: AS SHOWN
FILENAME: ROHE_MAINTAB

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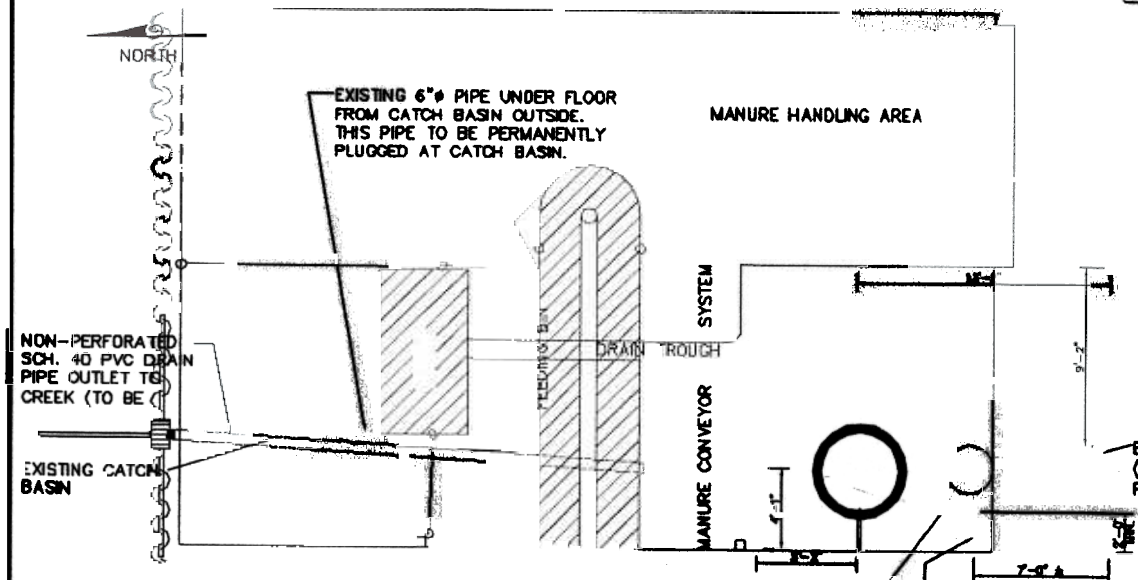
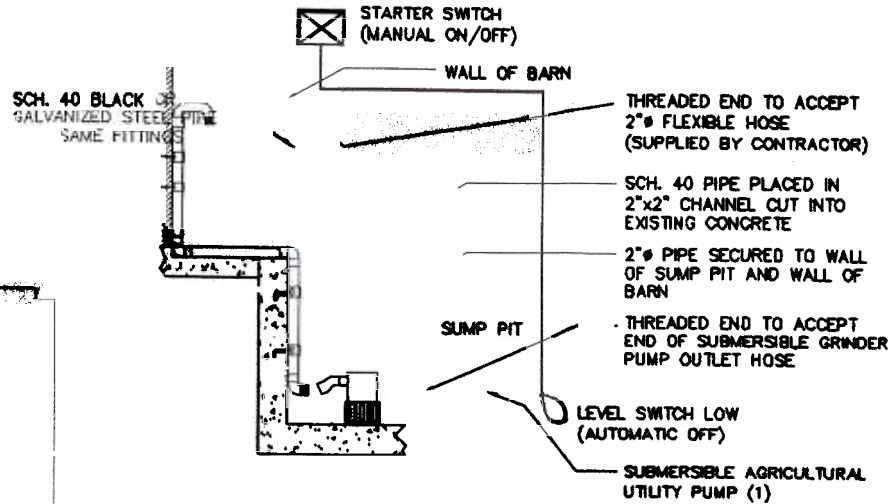
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

TIMBER CURB & STABILIZED ACCESS DETAILS
ROHE FARM
ONONDAGA COUNTY, NEW YORK



PLAN – MANURE HANDLING AREA



TYPICAL DETAIL – SUMP PIT OUTLET & CONTROLS

NOTES:

1. TEEL® 1/2 HP REVERSED SEAL PUMP WITH MANUFACTURER RECOMMENDED LEVEL SWITCH AND STARTER SWITCH, OR EQUAL

			PROJECT NO:	
			DATE:	03/31/00
			DRAWN BY:	TAS
			CHECKED BY:	JJL
			SCALE:	AS SHOWN
			FILENAME:	ROHE_MAP2.DWG

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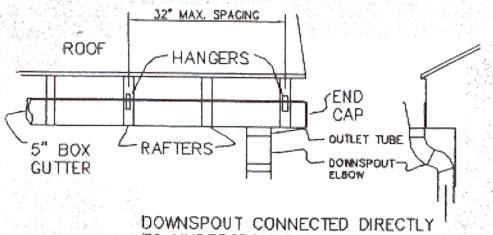
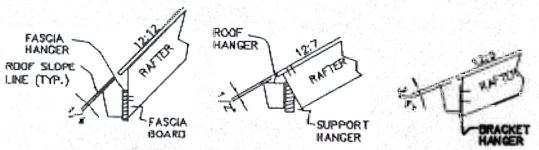
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

MANURE HANDLING AREA DETAILS
ROHE FARM
ONONDAGA COUNTY, NEW YORK

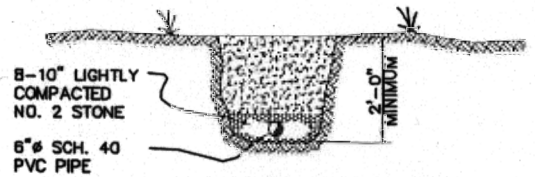
6



DOWNSPOUT CONNECTED DIRECTLY TO UNDERGROUND DRAIN



TYPICAL GUTTER DETAILS



TYPICAL DRAIN PIPE TRENCH DETAIL

1	ADDL SPECS. AND DESIGN CHANGES	4/26/00

PROJECT NO.
DATE: 05/31/00
DRAWN BY: TAS
CHECKED BY: JJL
SCALE: AS SHOWN
FILENAME: ROHE_MAP.DWG

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P.O. BOX 39
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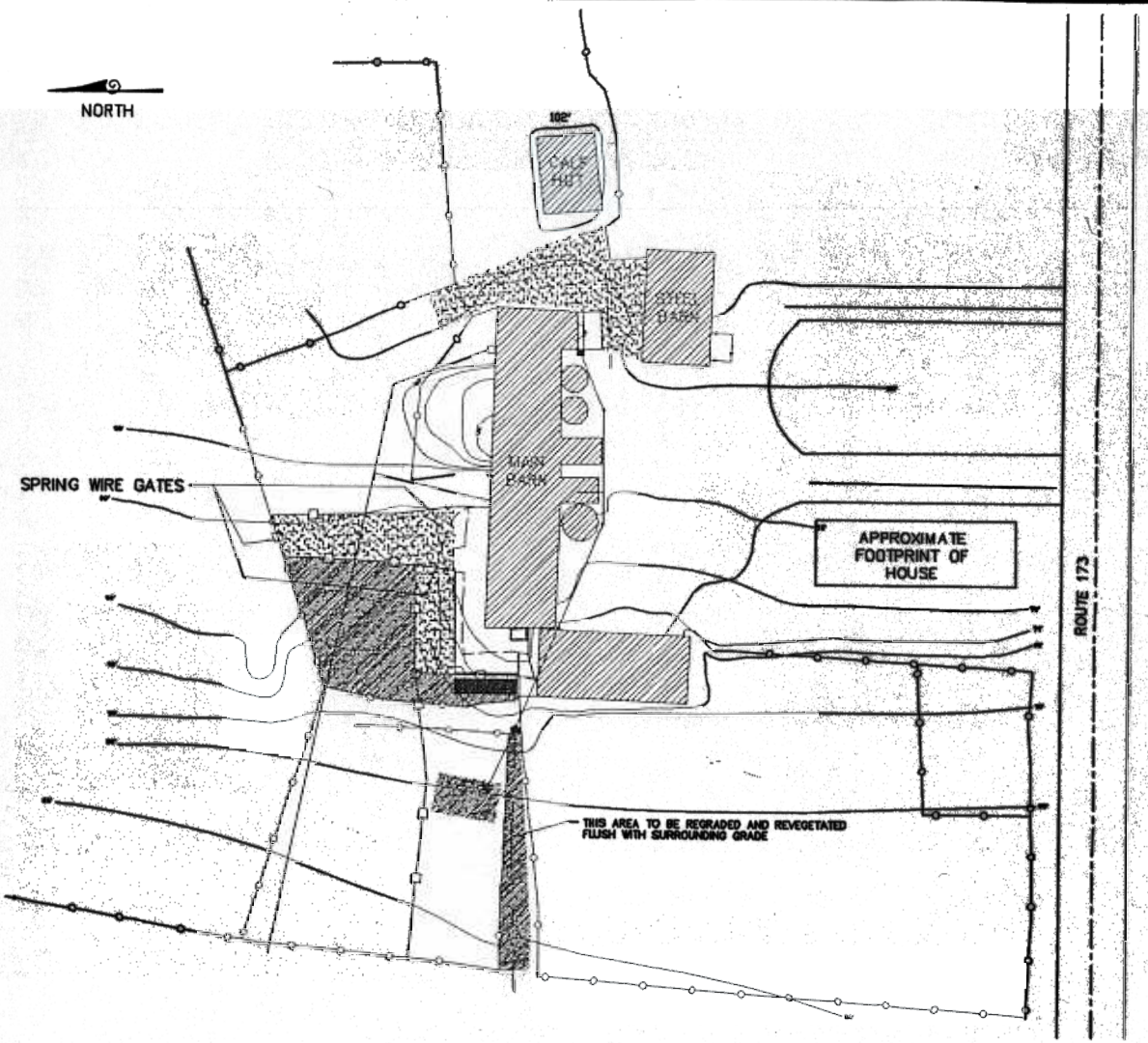
PHONE: (315) 446-3010
FAX: (315) 446-0445

PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
6"Ø PVC DRAIN PIPE AND GUTTER DETAILS
ROHE FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
7



AREAS TO BE REVEGETATED AND MULCHED. (SEE SEED AND MULCH SCHEDULE BELOW)

AREAS TO BE STABILIZED FOR EQUIPMENT AND ANIMAL ACCESS (SEE DETAIL SHEET 5)

NEW FENCE TO BE INSTALLED. (HIGH-TENSILE SINGLE STRAND)

EXISTING FENCE TO BE REMOVED.

SEED AND MULCH SCHEDULE

TALL FESCUE	30 LBS/ACRE
REED CANARY GRASS	30 LBS/ACRE
TOTAL	60 LBS/ACRE
MULCH	2 TONS/ACRE

REVEGETATION AND FENCE MODIFICATIONS

SCALE IN FEET

0 30 60 90 120 150

1	ADD'L SPECIAL AND DESIGN CHANGES	4/29/00	

PROJECT NO.:
DATE: 03/29/00
DRAWN BY: TAB
CHECKED BY: JJL
SCALE: AS SHOWN
FILENAME: ROHE_MAP.DWG

MOFFA & ASSOCIATES
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PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
VEGETATION PLAN & NEW FENCE LAYOUT
ROHE FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
8

Appendix B

Guptill Design Drawings

CONTRACT DRAWINGS
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT BOARD

DRAWINGS INDEXED BY CONTRACT:
EXISTING SITE LAYOUT (TITLE SHEET)

EARTHWORK AND CONCRETE
EC-1 PROPOSED MODIFICATIONS/ADDITIONS
EC-2 CONSTRUCTION DETAILS
EC-3 CONSTRUCTION DETAILS (CONTINUED)
EC-4 CONSTRUCTION DETAILS (CONTINUED)

EXTERIOR PLUMBING AND ELECTRICAL
PE-1 PROPOSED PIPING NETWORK FOR ALTERNATE WATER SUPPLY
PE-2 CONSTRUCTION DETAILS

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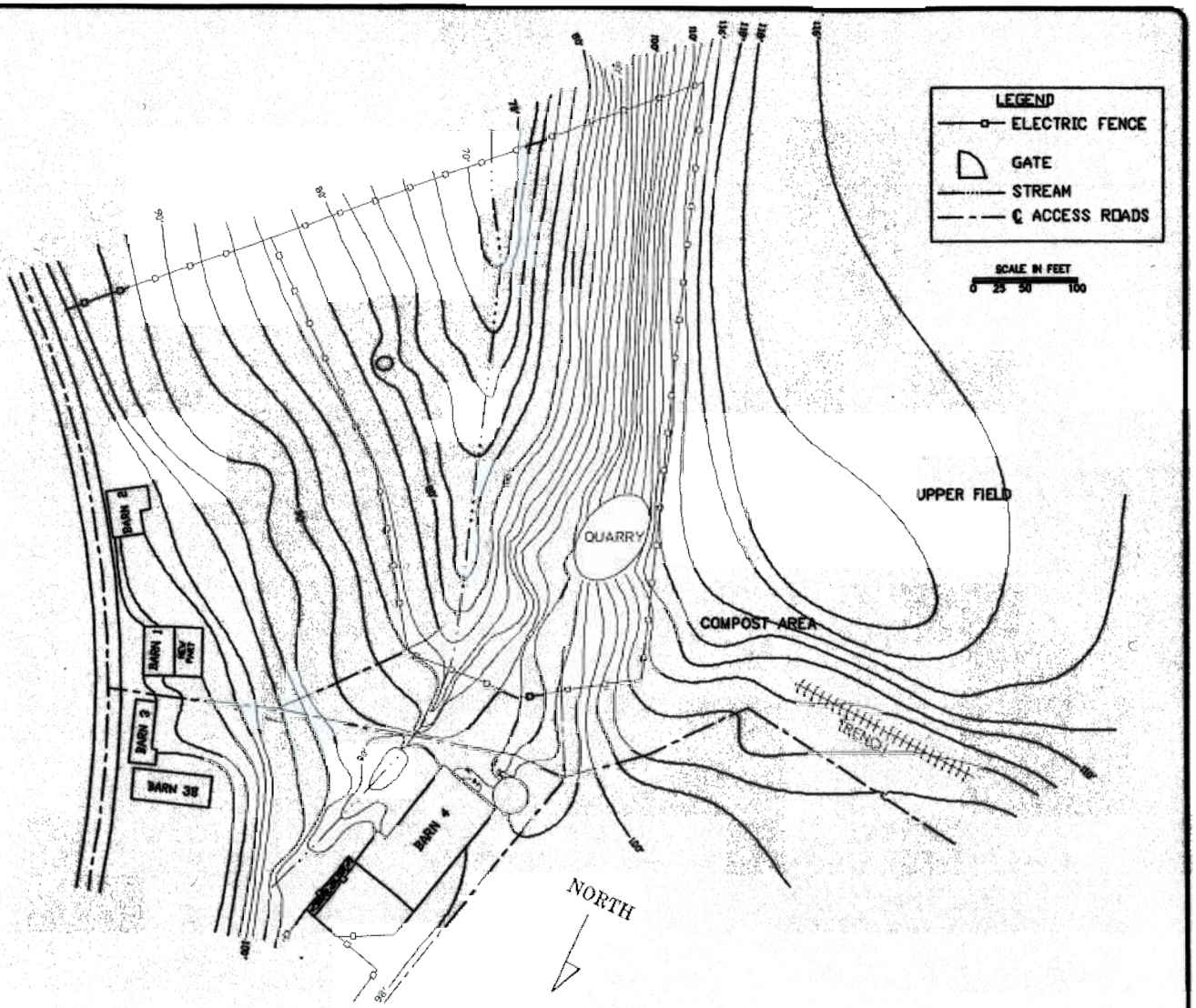
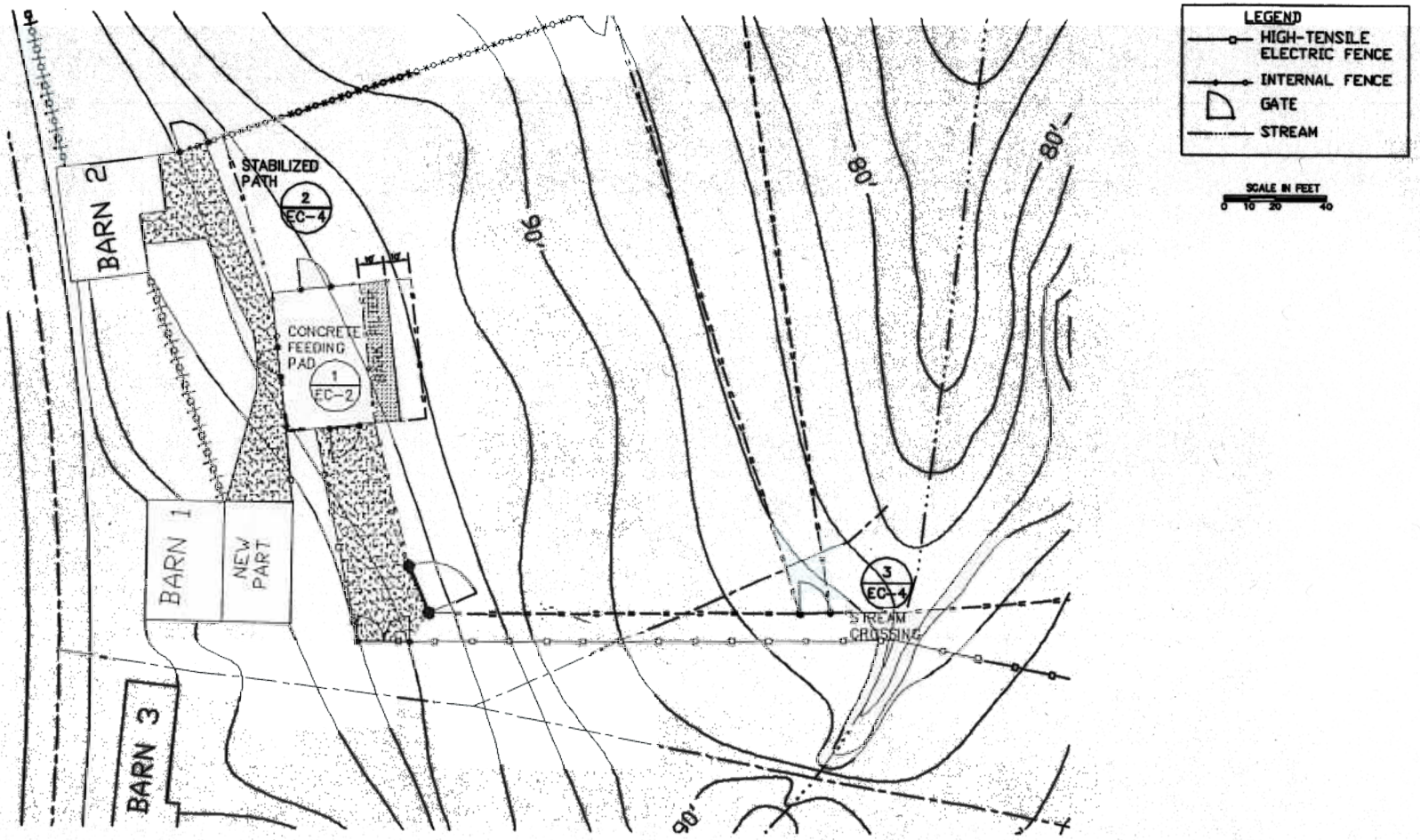
PHONE: (315) 446-3010
FAX: (315) 446-0443





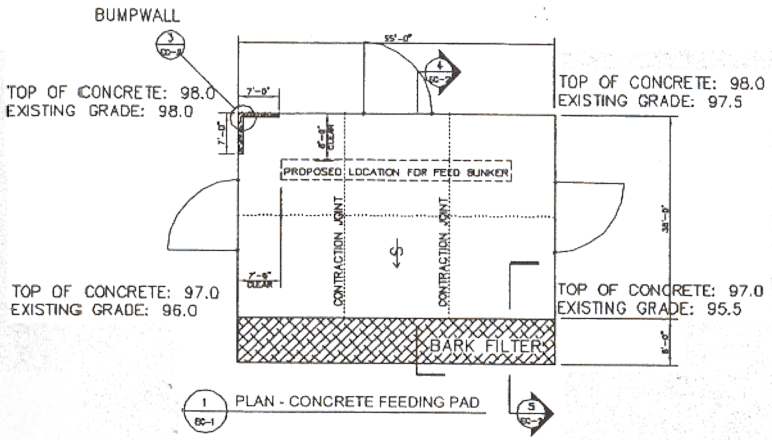
1	MINOR DESIGN MODIFICATIONS	4/28/06	PROJECT NO.#	1858-01-05
			DATE:	3/31/06
			DRAWN BY:	TDS
			CHECKED BY:	JAL
			SCALE:	AS SHOWN
			FILENAME:	GUPTILL CONTRACTDWG

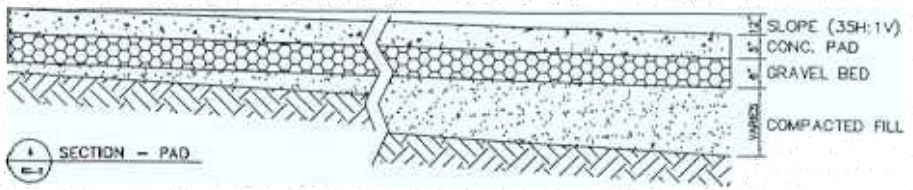
MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5710 COMMONS PARK
P.O. BOX 20
SYRACUSE, NY 13214
PHONE: (315) 449-3010
FAX: (315) 446-0443

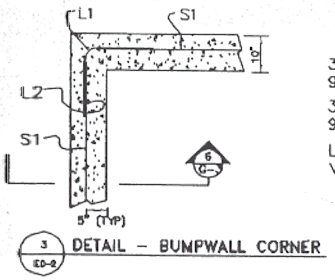
PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

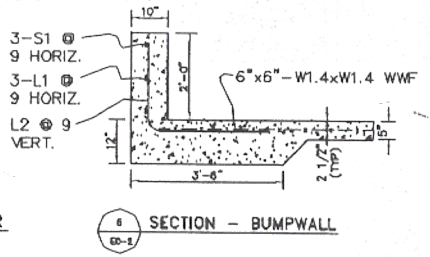
SHEET TITLE
PROPOSED MODIFICATIONS/ADDITIONS
GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
EC-1









NOTES:

1. CUT APPROXIMATELY 8" TO UNDERLYING MINERAL SOIL.
2. ALL CONCRETE TO BE 4000 PSI (ASTM C150) POURED @ 3 1/2" SLUMP
3. ALL STEEL TO CONFORM TO ASTM A615 - A617
4. FILL 6" LIFTS, COMPACT WITH THREE (3) PASSES OF A 2,500 LB. IMPACT FORCE VIBRATORY TAMPER.
5. 42"x40'-0"x19" FEED BUNKER TO BE SUPPLIED BY CONTRACTOR.

1	MINOR DESIGN MODIFICATIONS	9/28/09	PROJECT NO.:	163.01.08
			DATE:	3/31/09
			DRAWN BY:	TAB
			CHECKED BY:	JJL
			SCALE:	AS SHOWN
			FILENAME:	GUPTILL CONTRACTLOWD

MOFFA & ASSOCIATES
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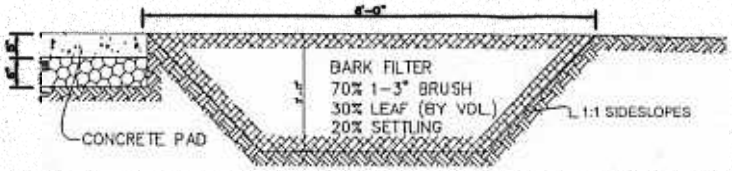
PHONE: (315) 446-3010
FAX: (315) 446-0443

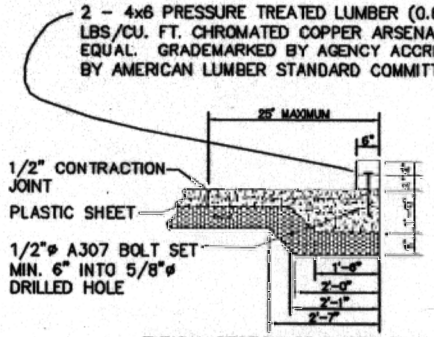
PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
CONSTRUCTION DETAILS
GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

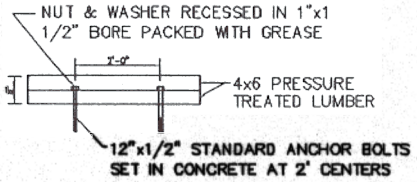
SHEET NO.
EC-2



3 SECTION – BARK FILTER

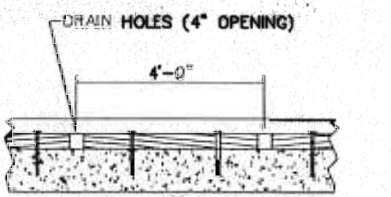


TYPICAL SECTION OF TIMBER CURB MOUNTED ON CONCRETE PAD



TYPICAL SECTION OF TIMBER CURB ASSEMBLY

HEIGHT OF CURB CAN BE VARIED BY ADDING AND NAILING 4x6 TIMBERS AS REQUIRED



TYPICAL SECTION TIMBER CURBING DRAIN HOLES

1	MINOR DESIGN MODIFICATIONS	4/30/08

PROJECT NO.	152.61.05
DATE	3/31/08
DRAWN BY	TAS
CHECKED BY	JAL
SCALE	AS SHOWN
FILENAME	GUPTILL CONTRACTORS

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5720 COMMONS PARK
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SYRACUSE, NY 13214
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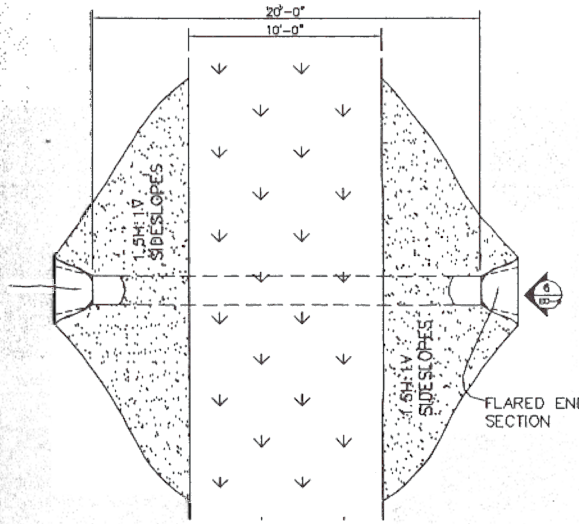
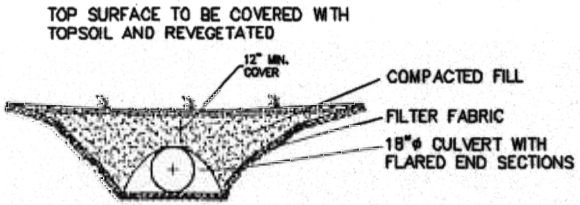
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

CONSTRUCTION DETAILS
GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

EC–3



3 EC-1 STREAM CROSSING



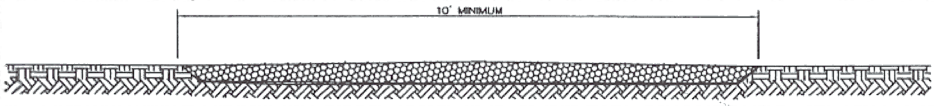
6 EC-4 ELEVATION - STREAM CROSSING

NOTES:

1. LINE CHANNEL WITH FILTER FABRIC (MIRAFI 140N OR EQUVALENT) PRIOR TO BACKFILLING.

2. CULVERT: CORRUGATED HDPE, DESIGNED FOR HS20 LOADING (AASHTO M294)

3. BACKFILL 12" LIFTS, COMPACTED WITH TWO PASSES OF 1,000 LB. IMPACT FORCE VIBRATORY TAMPER.



2 EC-1 TYPICAL SECTION - STABILIZED PATH

NOTES:

1. ACCESS ROAD TO BE EXCAVATED TO MINERAL SOIL, UNDERLAIN WITH 6 OZ. MUDGARD® OR EQUAL, THEN COVERED WITH 8-10" OF COMPACTED, NO. 2 STONE, ROCKDUST, OR APPROVED EQUIVALENT. FILL WITH TWO 4-5" LIFTS COMPACTED WITH THREE (3) PASSES OF A 72-84" VIBRATORY, MECHANICAL ROLLER.

2. TOP SURFACE OF ROAD SHALL BE SLIGHTLY CROWNED TO FACILITATE DRAINAGE.

NOTE:

ALL DISTURBED AREAS SHALL BE TOPSOILED, SEEDED AND MULCHED AS SPECIFIED;

COMMON WHITE CLOVER*	8 LBS./ACRE
TALL FESCUE	20 LBS./ACRE
PERRENIAL RYEGRASS	5 LBS./ACRE

*INNOCULATE IMMEDIATELY PRIOR TO SEEDING

MINIMUM OF 4" TOPSOIL
FIRMING WITH 100 LB ROLLER FOR GOOD SEED-SOIL CONTACT
MULCHING WITH STRAW 2 PER ACRE

SYMBOL	REVISION	DATE
1	MINOR SCREEN MODIFICATIONS	4/28/08

PROJECT NO.: 155.01.08
DATE: 3/31/08
DRAWN BY: TAS
CHECKED BY: JJL
SCALE: AS SHOWN
FILENAME: GUPTILL CONTRACT.DWG

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P.O. BOX 35
SYRACUSE, NY 13214
PHONE: (315) 446-3010
FAX: (315) 446-0443

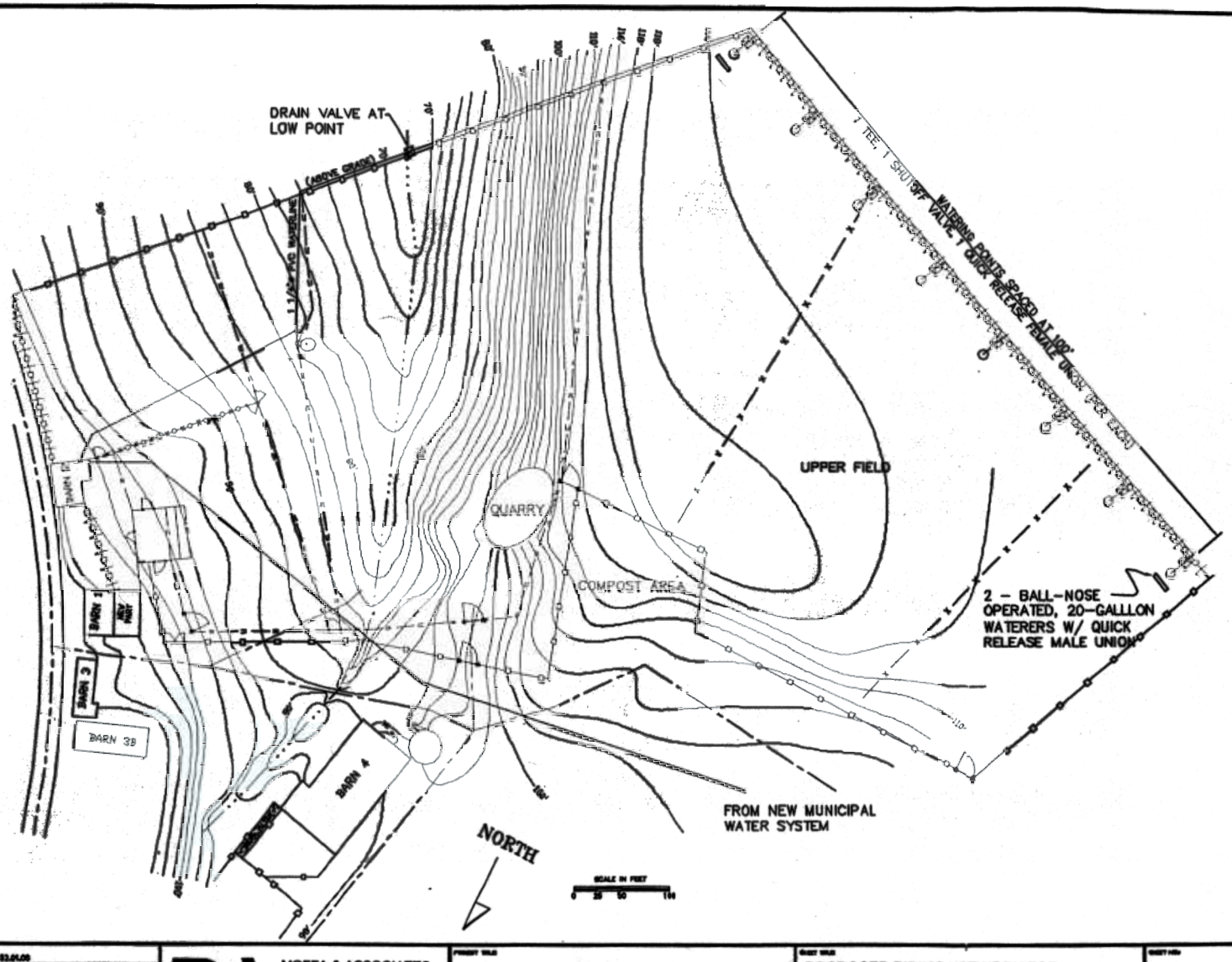
PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
CONSTRUCTION DETAILS
GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
EC-4

NOTE:

ALL PIPE AND FITTINGS TO BE NSF APPROVED.



1	MINOR DESIGN MODIFICATIONS	3/31/10	PROJECT NO.:	183.04.09
			DATE:	3/31/10
			DRAWN BY:	TJS
			CHECKED BY:	JJL
			SCALE:	AS SHOWN
			REVISIONS:	SUPPLEMENTAL CONTRACT 2/10

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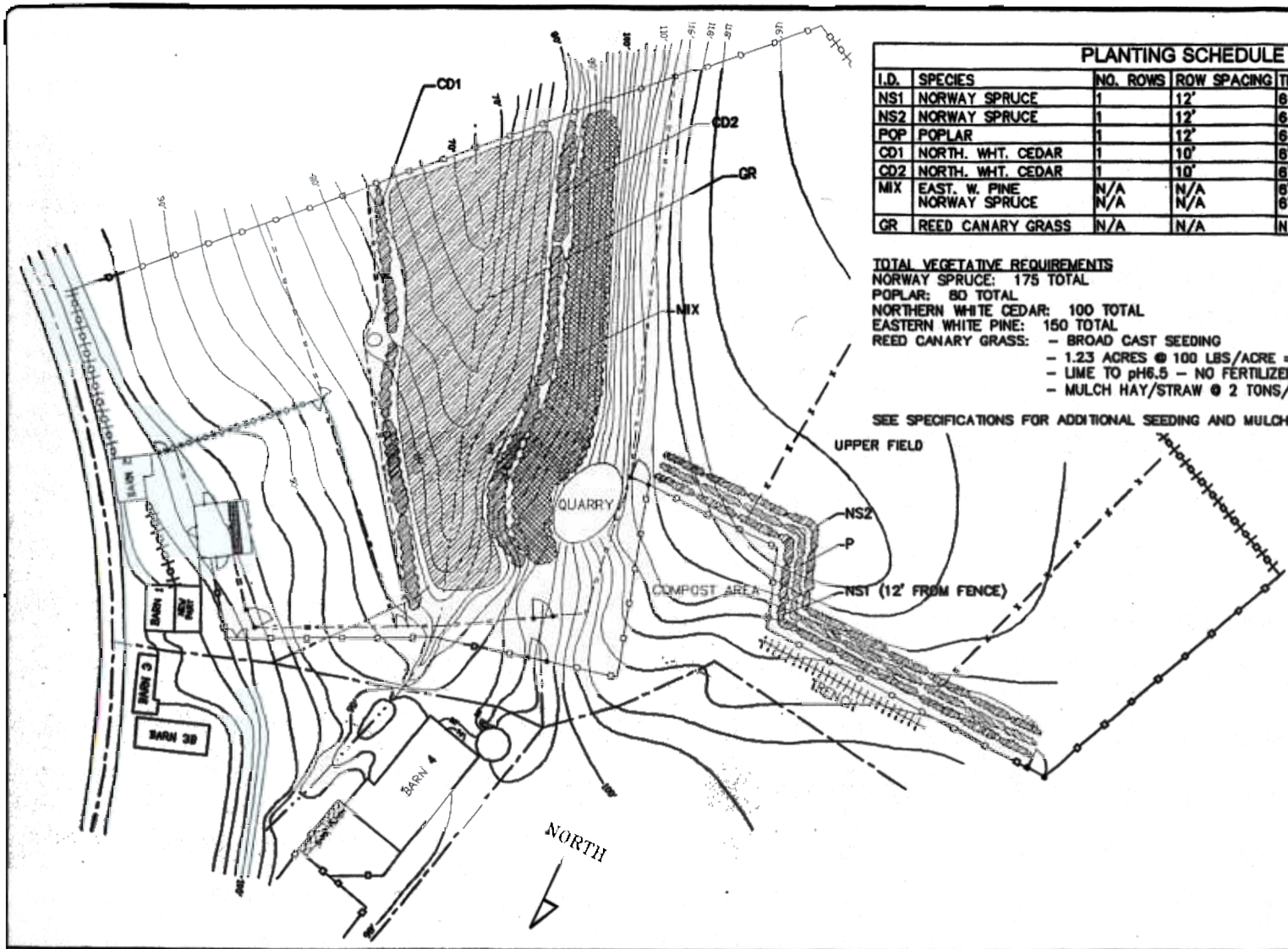
FAX: (315) 446-0463

PROJECT TITLE:
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE:
PROPOSED PIPING NETWORK FOR
ALTERNATE WATER SUPPLY
GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
PE-1



PLANTING SCHEDULE

I.D.	SPECIES	NO. ROWS	ROW SPACING	TREE SPACING	TOTAL QNTY.
NS1	NORWAY SPRUCE	1	12'	6-8'	75 SEEDLINGS
NS2	NORWAY SPRUCE	1	12'	6-8'	75 SEEDLINGS
POP	POPLAR	1	12'	6-8'	80 TRANSPLANTS
CD1	NORTH. WHT. CEDAR	1	10'	6' MIN.	50 SEEDLINGS
CD2	NORTH. WHT. CEDAR	1	10'	6' MIN.	50 SEEDLINGS
MIX	EAST. W. PINE NORWAY SPRUCE	N/A N/A	N/A N/A	6' MIN. 6' MIN.	150 TRANSPLANTS 25 SEEDLINGS
GR	REED CANARY GRASS	N/A	N/A	N/A	100 LBS/ACRE

TOTAL VEGETATIVE REQUIREMENTS
NORWAY SPRUCE: 175 TOTAL
POPLAR: 80 TOTAL
NORTHERN WHITE CEDAR: 100 TOTAL
EASTERN WHITE PINE: 150 TOTAL
REED CANARY GRASS:
- BROAD CAST SEEDING
- 1.23 ACRES @ 100 LBS/ACRE = 123 LBS. (SEED)
- LIME TO pH6.5 - NO FERTILIZER REQUIRED
- MULCH HAY/STRAW @ 2 TONS/ACRE

SEE SPECIFICATIONS FOR ADDITIONAL SEEDING AND MULCHING REQUIREMENTS

1	MINOR BORDER MODIFICATIONS	4/28/00	
PROJECT NO.:	163.01.03		
DATE:	4/7/00		
DRAWN BY:	TM		
CHECKED BY:	JR		
SCALE:	AS SHOWN		
PREPARED:	GUPTILL CONTRACTORS		

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5710 COMMONS PARK
P.O. BOX 26
SYRACUSE, NY 13211
PHONE: (315) 446-3010
FAX: (315) 446-0443

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

PLANTING LAYOUT AND SCHEDULE
GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

V-1

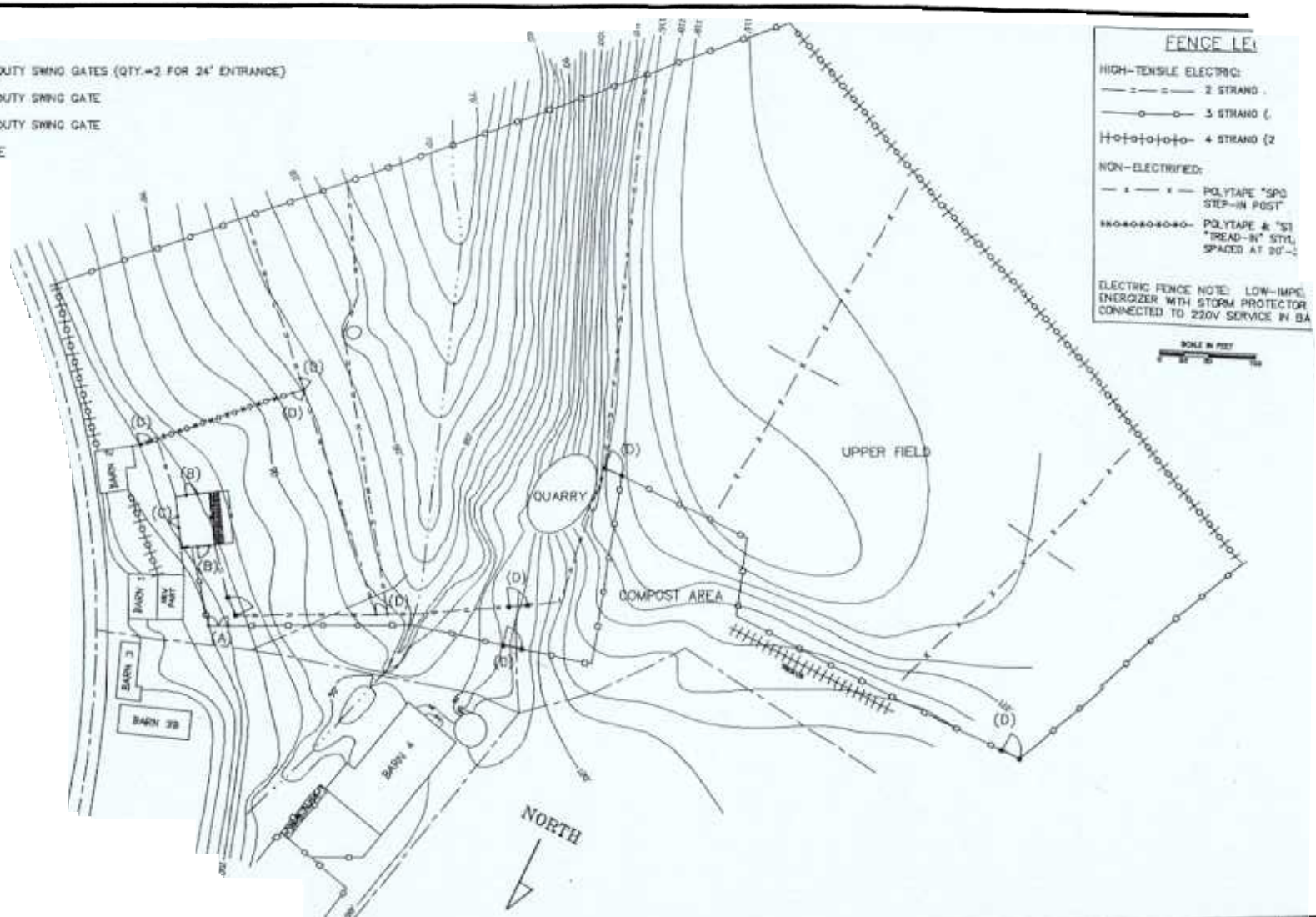
GATE TYPES

(A) 12' HEAVY DUTY SWING GATES (QTY.=2 FOR 24' ENTRANCE)

(B) 12' HEAVY DUTY SWING GATE

(C) 10' HEAVY DUTY SWING GATE

(D) SPRING GATE



DATE	4/7/09
DRAWN BY	TJG
CHECKED BY	JJL
SCALE	AS SHOWN
PLOTTED	GUPTILL CONTRACTORS

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5793 COMMERCE PARK
P.O. BOX 28
SYRACUSE, NY 13214
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ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

PROPOSED FENCE LAYOUT
GUPTILL FARM
ONONDAGA COUNTY, NEW YORK

F-1

Appendix C

Leubner Design Drawings

CONTRACT DRAWINGS

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

LUEBNER FARM
ONONDAGA COUNTY, NEW YORK

CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT BOARD

INDEX OF SHEETS:

TITLE SHEET: EXISTING SITE LAYOUT AND DRAWING KEY

SHEET 1: BUNK SILAGE SUMP
SHEET 2: STALL BARN DRAIN & FILTER
SHEET 3: VEGETATED WATERWAY & RETENTION AREA
SHEET 4: MAIN BARN FILTER, CONCRETE BUMPWALL, & TIMBER CURBING
SHEET 5: CULVERT AND EXPLORATORY TRENCH
SHEET 6: OTHER ITEMS AND DETAILS

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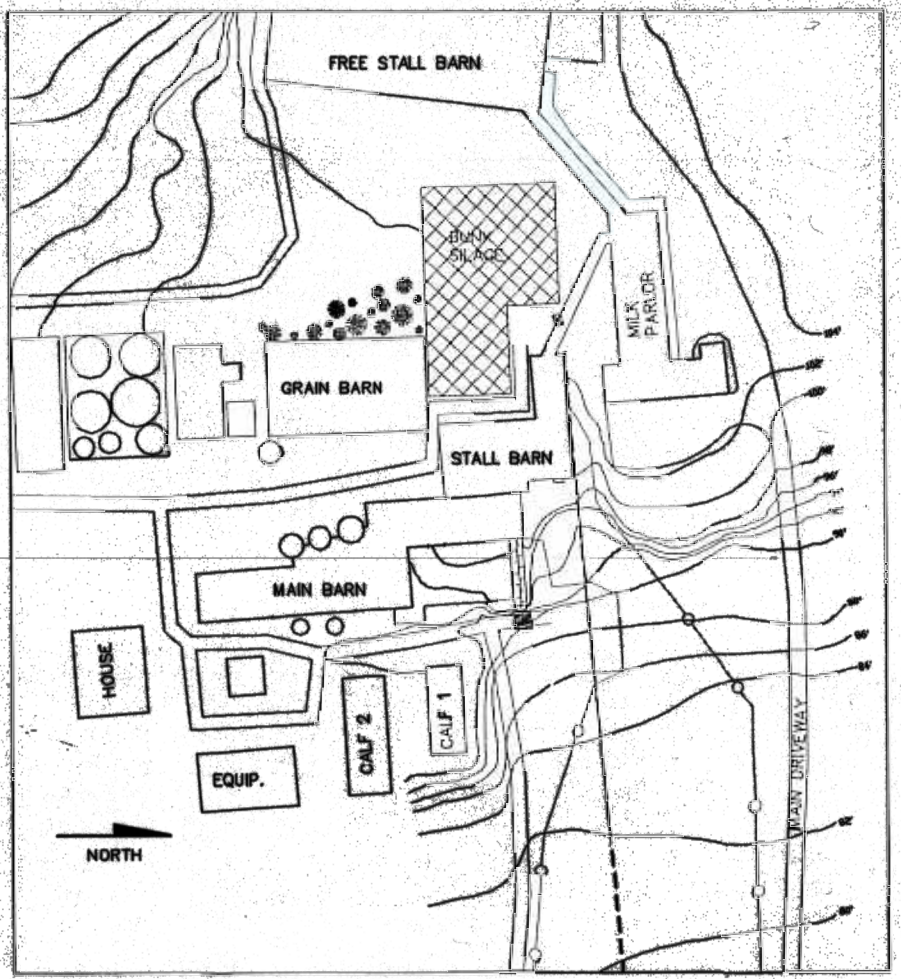
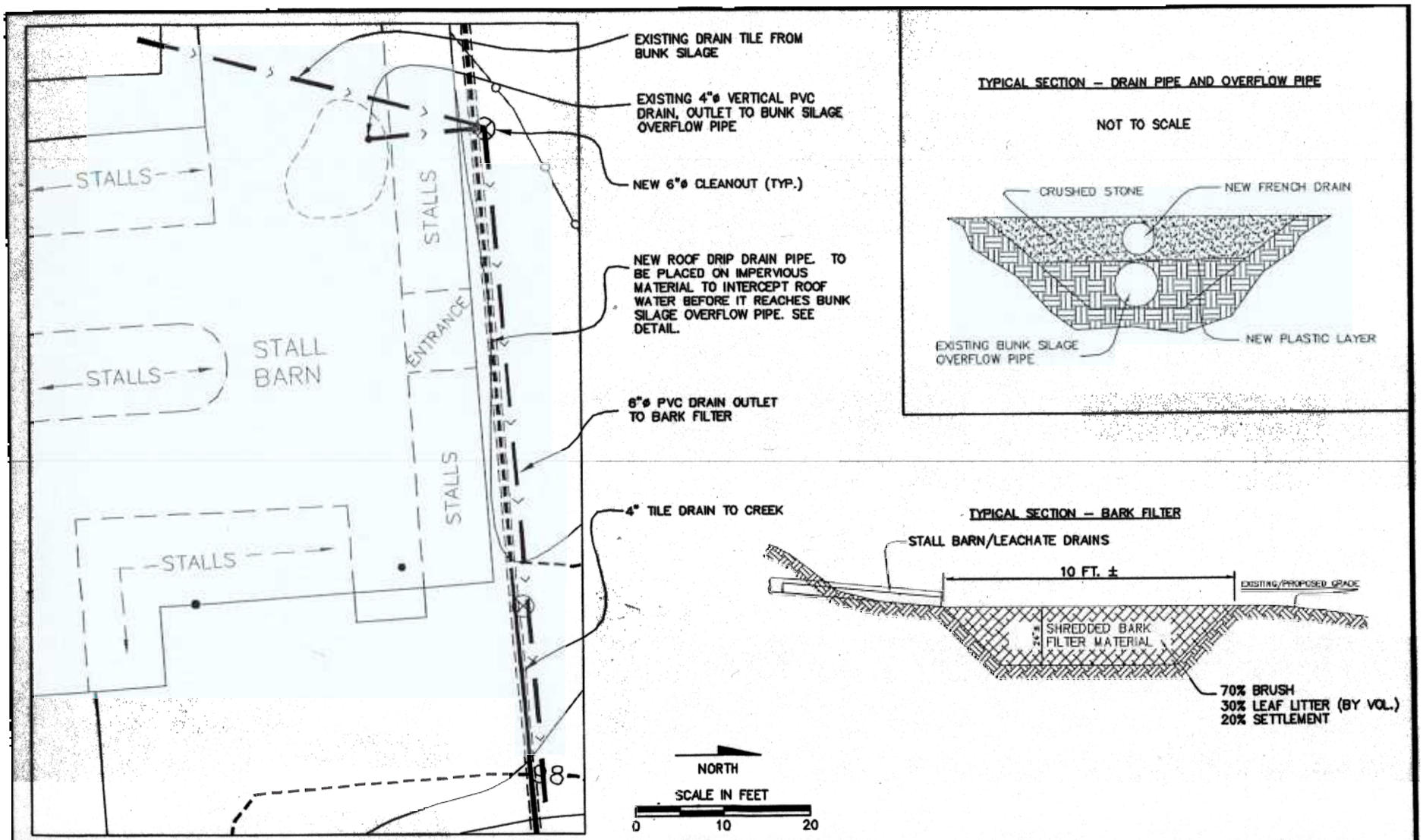
P.O. BOX 26
SYRACUSE, NY 13214
PHONE: (315) 446-3010
FAX: (315) 446-6443



EXISTING SITE LAYOUT

SCALE IN FEET

0 100 200



1	DESIGN MODIFICATIONS/ADDITIONS	5/20/20

PROJECT NO.:
DATE: 1/5/20
DRAWN BY: TAB
CHECKED BY: JJL
SCALE: AS SHOWN
FILENAME: LUEBNER HOLDING

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5715 COMMONS PARK
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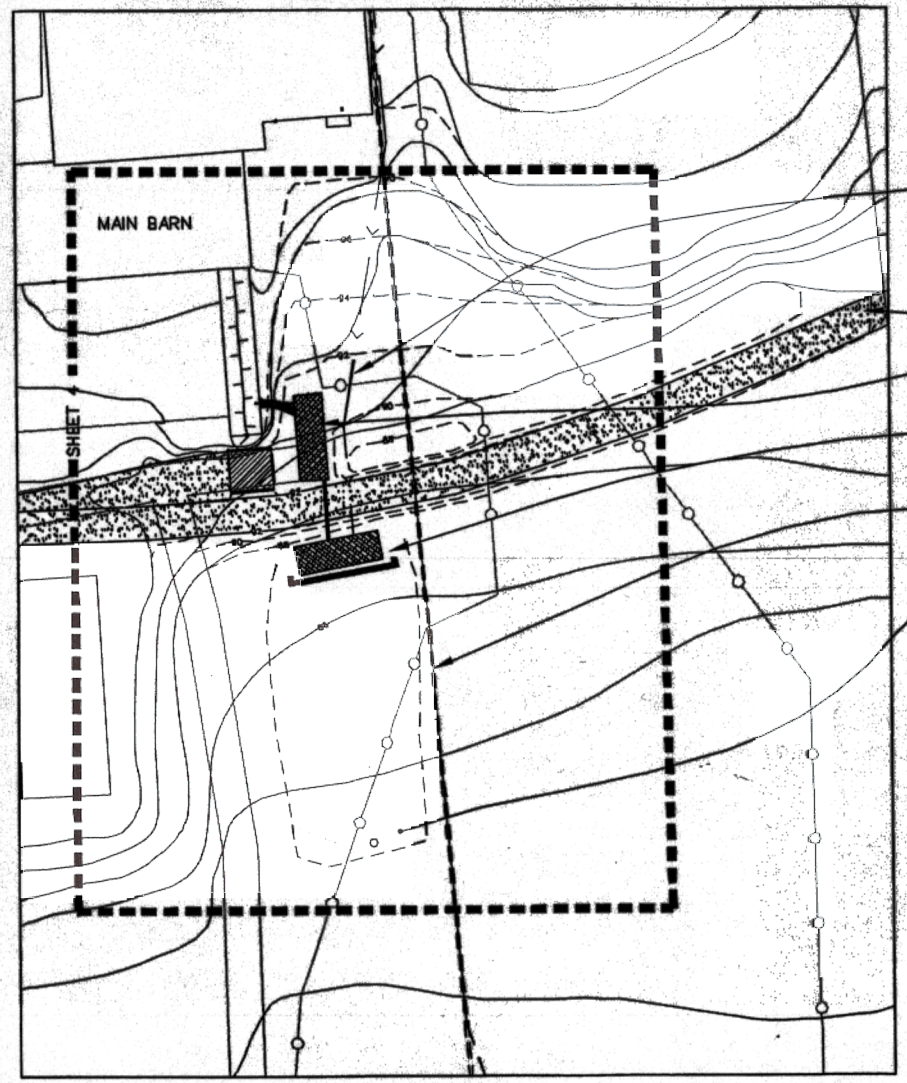
PHONE: (315) 446-2010
FAX: (315) 446-0443

PROJECT TITLE:
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE:
STALL BARN DRAIN & FILTER
LUEBNER FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.: 2



6"ø PVC PIPE FROM BULK SILO TO BARK FILTER.

STABILIZED ACCESS ROAD (TO BE CONSTRUCTED BY OWNER)

BARK FILTER.

BARK FILTER W/ GABION ROCK FLOW SPLITTER.

NEW ROOF DRIP DRAIN OUTLET PIPE TO DITCH.

DETENTION AREA W/ HICKIN BOTTOM STANDPIPE OUTLET. SEED AND MULCH AS SCHEDULED.

NOTE:
COORDINATE GRADING AND EARTHWORK WITH REMOVAL OF EXISTING DRAIN TILE (FRENCH DRAIN PIPE) – LOCATION TO BE DETERMINED IN FIELD AT TIME OF CONSTRUCTION.

SEED AND MULCH SCHEDULE

TALL FESCUE	30 TONS/ACRE
REED CANARY GRASS	30 TONS/ACRE
TOTAL	6 TONS/ACRE
MULCH	2 TONS/ACRE

NORTH

SCALE IN FEET

0 30 60

SYMBOL	REVISION	DATE
1	DESIGN MODIFICATIONS/ADDENDA	4/25/08

PROJECT NO.:
DATE: 4/8/08
DRAWN BY: TNS
CHECKED BY: AJL
SCALE: AS SHOWN
FILENAME: LUEBNER REVISED

MOFFA & ASSOCIATES
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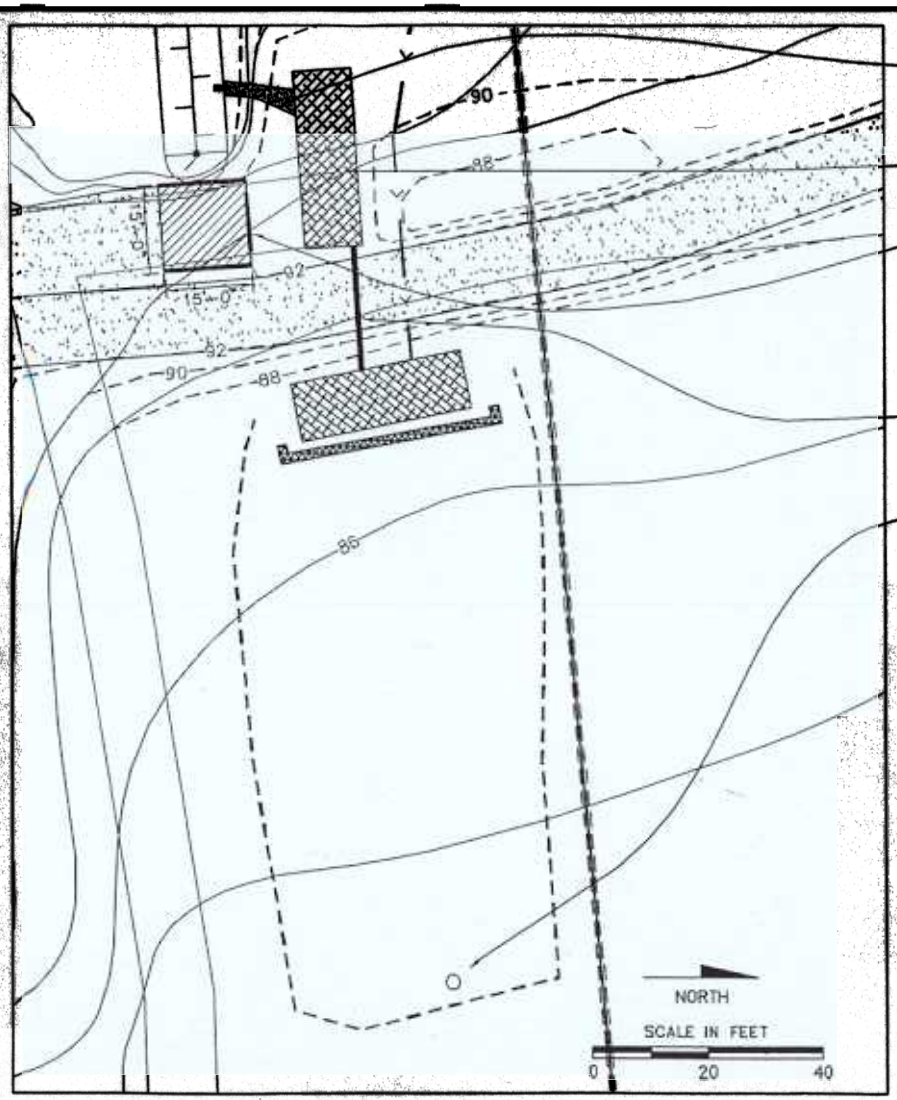
PROJECT TITLE:
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE:
VEGETATED WATERWAY & RETENTION AREA
LUEBNER FARM
ONONDAGA COUNTY, NEW YORK

SHEET No.
3



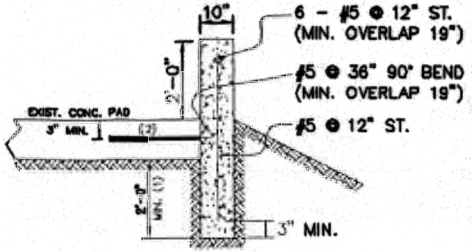
2-FT. WIDE, CONCRETE-LINED OUTLET CHANNEL (FROM OUTLET OF RAMP DRAIN PIPE TO BARK FILTER)

MAIN BARN BARK FILTER - SURFACE ELEV. @ 91.0' ±

EXISTING CONCRETE PAD TO BE EXPOSED. NEW 10'-LONG BUMPWALL TO BE CONSTRUCTED ALONG NORTH EDGE AND NEW TIMBER CURBING TO BE INSTALLED ALONG EAST AND WEST EDGES (PAD ELEV. APPROX. 92.0')

24"ø CORRUGATED HDPE CULVERT W/FLANGED END SECTIONS.

RETENTION AREA W/ HICKIN BOTTOM STANDPIPE OUTLET.



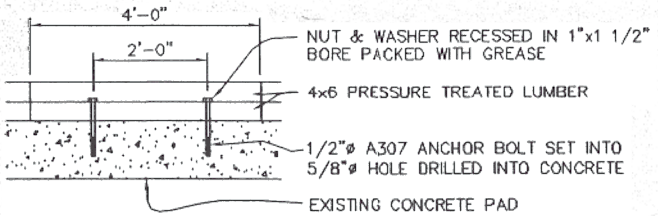
TYPICAL SECTION - CONCRETE BUMPWALL

NOTES:

1. DEPTH OF WALL BELOW GRADE GREATER THAN OR EQUAL TO HEIGHT OF WALL ABOVE PAD.

2. 90° BARS TO BE EMBEDDED MINIMUM 28" INTO EXISTING CONCRETE PAD. USE 7/8"ø DRILLED HOLE FILLED WITH EPOXY GROUT.

3. USE 4000 PSI CONCRETE POURED @ 3½" SLUMP.



TYPICAL DETAIL OF TIMBER CURB ASSEMBLY

HEIGHT OF CURB CAN BE VARIED BY ADDING AND NAILING 4x6 TIMBERS AS REQUIRED

NO.	REVISION	DATE
1	DESIGN MODIFICATIONS/ADDITIONS	4/28/00

PROJECT NO.:
DATE: 4/5/00
DRAWN BY: TAS
CHECKED BY: JJL
SCALE: AS SHOWN
FILENAME: LUEBNER HYDRO

MOFFA & ASSOCIATES
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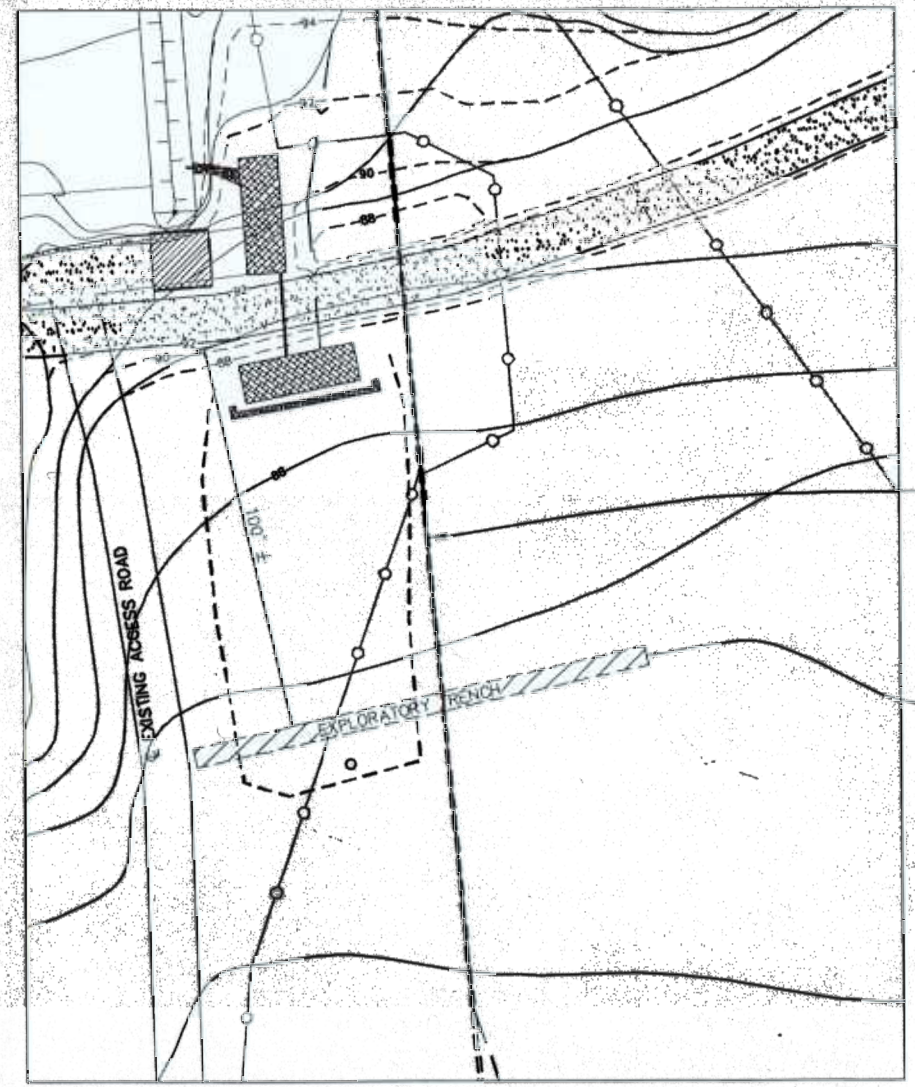
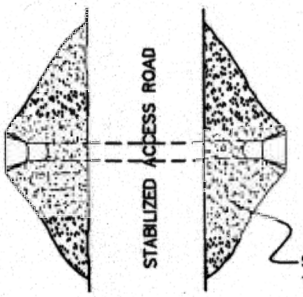
PROJECT TITLE:
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

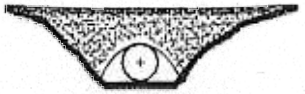
SHEET TITLE:
MAIN BARN FILTER, CONCRETE BUMPWALL, & TIMBER CURBING
LUEBNER FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.: 4





TYPICAL DETAIL
CULVERT W/ FLANGED
END SECTIONS



TYPICAL ELEVATION
CULVERT W/ FLANGED
END SECTIONS

NOTE:

1. BACKFILL TO BE PLACED IN 12" LIFTS AND COMPACTED WITH TWO PASSES OF A 1,000–LB IMPACT FORCE VIBRATORY TAMPER.

PRESUMED LOCATION OF EXISTING FRENCH DRAIN PIPE. TO BE REPLACED WITH NEW NON–PERFORATED SCH. 40 PVC DRAIN PIPE. (APPROX. 320' OF NEW PIPE)

120' LONG BY 6' DEEP EXPLORATORY TRENCH REQUIRED TO DETERMINE LOCATION OF EXISTING FRENCH DRAIN PIPE.

NORTH

SCALE IN FEET

0 30 60

1	[illegible]	[illegible]	
		DATE	4/8/09
		DRAWN BY	MB
		CHECKED BY	JAL
		SCALE	AS SHOWN
		FILENAME	LUEBNER MEMO.DWG

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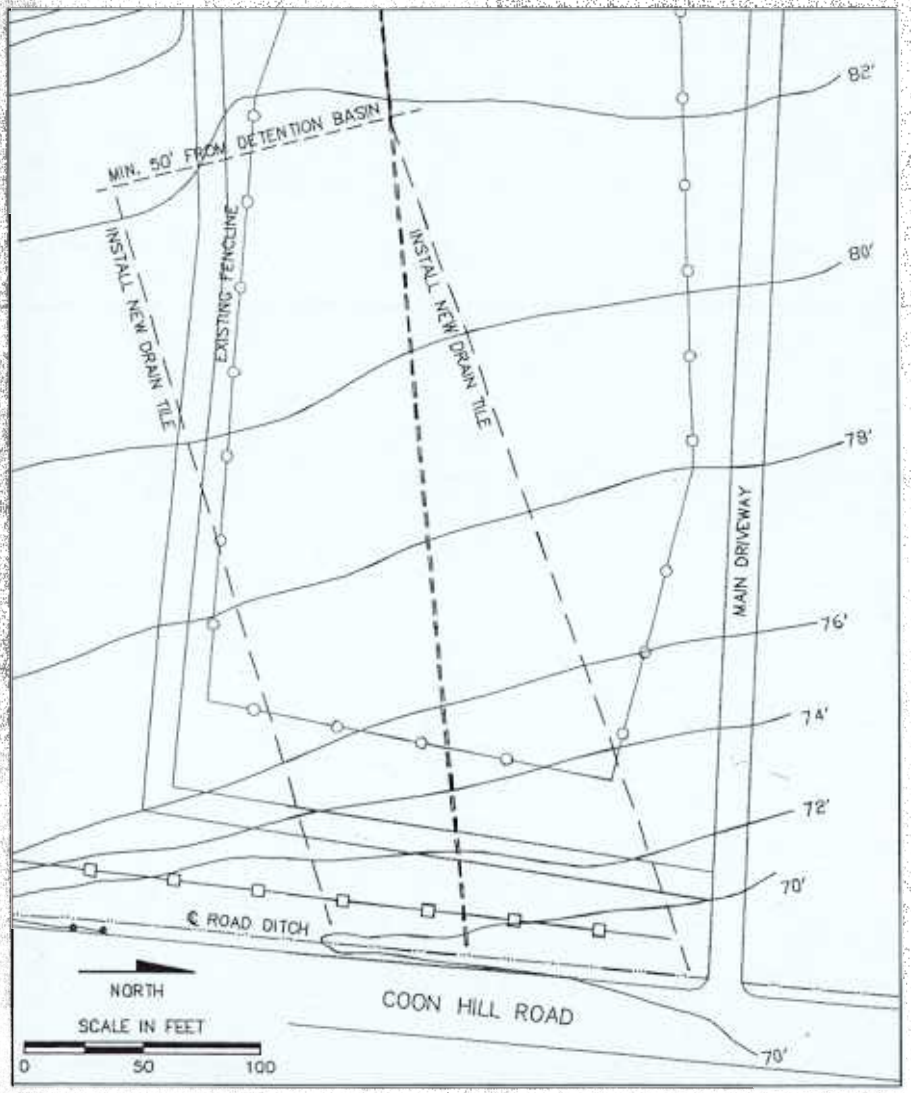
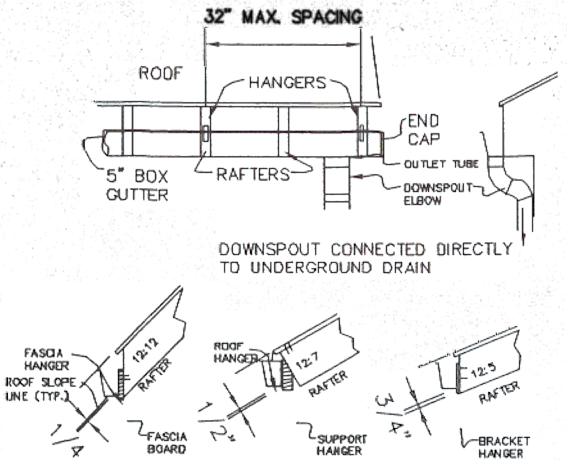
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

CULVERT AND EXPLORATORY TRENCH
LUEBNER FARM
ONONDAGA COUNTY, NEW YORK





TYPICAL GUTTER DETAILS

NOTES:

1. APPROXIMATELY 100 FEET OF GUTTERS TO BE INSTALLED/REPLACED ON MAIN BARN AT LOCATIONS IDENTIFIED BY ENGINEER IN FIELD DURING CONSTRUCTION PHASE.

2. APPROXIMATELY 700 FEET OF NEW 8"ø DRAIN TILE TO BE INSTALLED IN LOWER FIELD AT LOCATIONS SHOWN. NEW FRENCH DRAIN PIPE TO OUTLET INTO NORTHERNMOST TILE LINE.

1	ADDITIONS/REVISIONS	4/20/00	

PROJECT NO.:
DATE: 4/20/00
DRAWN BY: TAS
CHECKED BY: JL
SCALE: AS SHOWN
FILENAME: LUEBNER WORKING

MOFFA & ASSOCIATES
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SYRACUSE, NY 13214
PHONE: (315) 445-2010
FAX: (315) 445-0445

PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
OTHER ITEMS AND DETAILS
LUEBNER FARM
ONONDAGA COUNTY, NEW YORK

SHEET NO.
6

Appendix D

Storm Water Vortex Memo

MEMORANDUM

	File	**CC:**	
From:	John LaGorga	**Date:**	12/1/99
RE:	SW flow through treatment device	**File:**	152.01

A stormwater flow-through treatment device will be installed and evaluated as part of the EBP. The main objective of installing this type of device is to remove gross solids and coincidental nutrients from stormwater. This device will be installed on East Seneca Turnpike, two blocks east of South Salina Street.

The following five devices were evaluated:

- HIL Technologies (Downstream Defender)
- Stormceptor
- Vortechnics
- CDS Technologies
- Stormwater Management

The Stormwater Management device was eliminated at the beginning of the selection process because it is a filter system that is designed to remove pollutants such as nutrients. The other devices are specifically designed to remove grit, floatable debris and oil. Additionally, the capital cost and O&M costs for this device are greater than the proposed budget.

Based on conversations with the manufactures and review of the manufactures' engineering catalogs, the HIL Technologies Downstream Defender was selected as the most appropriate device for the EBP. Table 1 illustrates the selection process evaluation. The Downstream Defender is one of the simplest and least expensive, yet effective devices. The Downstream Defender utilizes "vortex" action to remove solids; many of the other devices do not. The Downstream Defender also has one of the smallest facility footprints; vortex units generally handle larger flow volumes per unit size.

	Downstream Defender	Stormceptor	CDS Tech	Vortechnics	SW Management
Facility Footprint	Small	Small	Large	Large	Large
Vortex Action	Yes[1]	No	No	Yes[1]	No
Maintenance[2]	Low	Low	High	Low[3]	Very High
Grit Storage[4]	0.75 yds	0.25 yds	1.25 yds	1.5 yds	NA
Removal Eff.[5]	0.5mm = 40% 1.0mm = 60% 5.0mm = 90%	TSS = 50-80%	0.5mm = 40% 1.0mm = 80% 5.0mm = 90%	Sand = 88% Silt = 55%	NA
Cost[6]	$10,000	$40,000	$40,000	$18,000	$60,000

Notes:

(1) Vortechnics: vortex action occurs in the same chamber as grit storage. Downstream Defender: grit storage in sump below the vortex chamber.

(2) All devices require a vactor truck for cleaning.

(3) This device uses a screen that may require additional maintenance.

(4) Grit storage for 3-4 cfs capacity.

(5) Removal efficiency based on manufactures' data. These data represent particle size removed at design flow conditions.

(6) Cost for 3-4 cfs capacity. Cost does not include installation. .

NA: Not applicable. The Stormwater Management Unit was designed to capture solids.

Appendix E

Downstream Defender Design Drawings

CONTRACT DRAWINGS

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

EAST SENECA TURNPIKE DOWNSTREAM DEFENDER
ONONDAGA COUNTY, NEW YORK

CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT BOARD

INDEX OF DRAWINGS

DD-1 AREA MAP (TITLE SHEET)
DD-2 LAYOUT DETAILS
DD-3 MANHOLE DIVERSION DETAILS
DD-4 GENERAL ARRANGEMENT DETAILS

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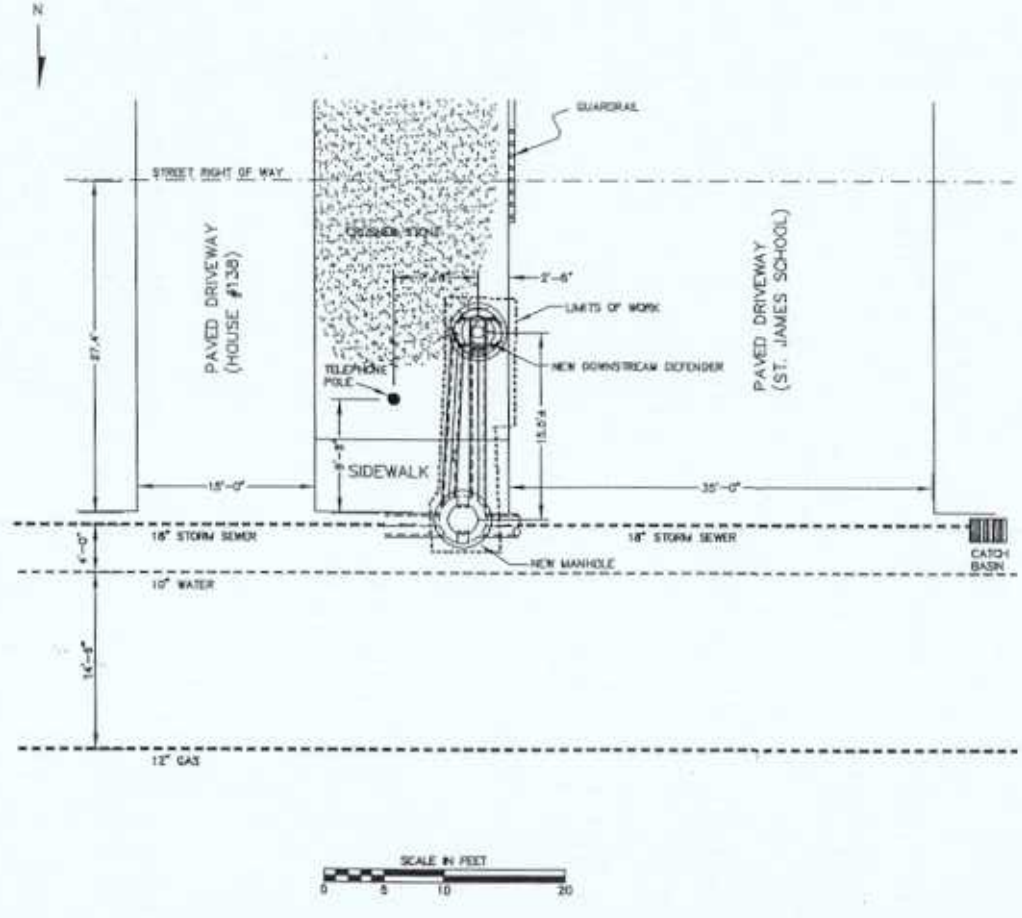
PHONE: (315) 449-3010
FAX: (315) 449-0443



PROJECT NO.:	156.04.06
DATE:	6/6/2006
DRAWN BY:	MS
CHECKED BY:	JAL
SCALE:	AS SHOWN
FILENAME:	ONWSTRM DEFENDER.DWG

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5710 COMMONS PARK
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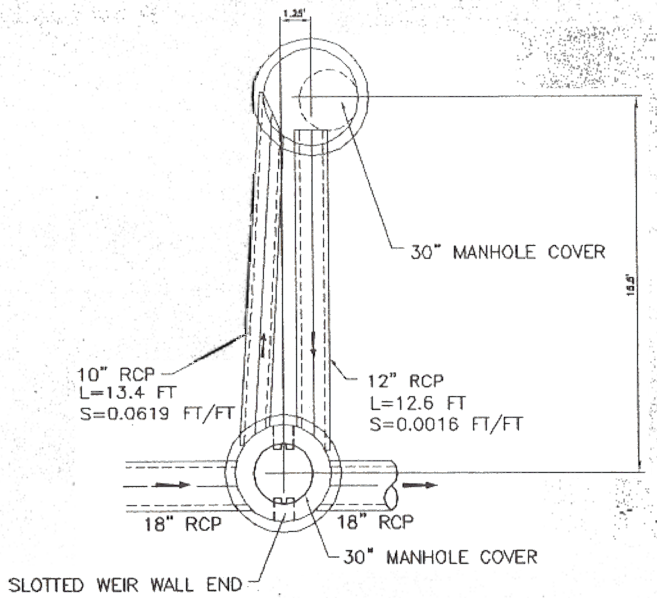
SYRACUSE, NY 13214
PHONE: (315) 449-3010, FAX: 449-0443

PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
AREA MAP
EAST SENECA TRNPK. DOWNSTREAM DEFENDER
CORNER OF SENECA DR. AND E. SENECA TRNPK.
ONONDAGA COUNTY, NEW YORK

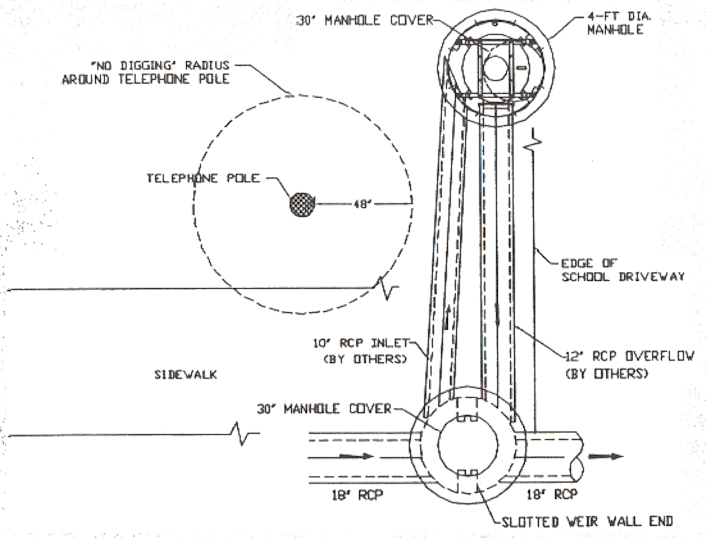
SHEET NO.
DD-1

4-FT DOWNSTREAM DEFENDER



PROPOSED OFFSET 4-FT DIVERSION MANHOLE (BY OTHERS)

4-FT DOWNSTREAM DEFENDER



PROPOSED OFFSET 4-FT DIVERSION MANHOLE (BY OTHERS)

Notes
1. THIS DRAWING IS A LETTER SIZE ORIGINAL.

Rev	By	Date	Description

Date 04/20/00 Scale 1" = 1'-0"

Drawn by MRJ | Checked Eng.

Checked Prod. | Approved by

Title
4-FT. DIA. DOWNSTREAM DEFENDER™ WITH BYPASS
ONONDAGA LAKE WATERSHED PROJECT

PLAN VIEW

H.I.T. TECHNOLOGY INC.

CAD Ref: DDP1
Wipe No. 2000/034
Drawing No. DA2 Rev. A

DRAWN BY	
CHECKED BY	
SCALE	AS SHOWN
FILENAME	PANTRY DEFENDER.DWG

MOFFA & ASSOCIATES
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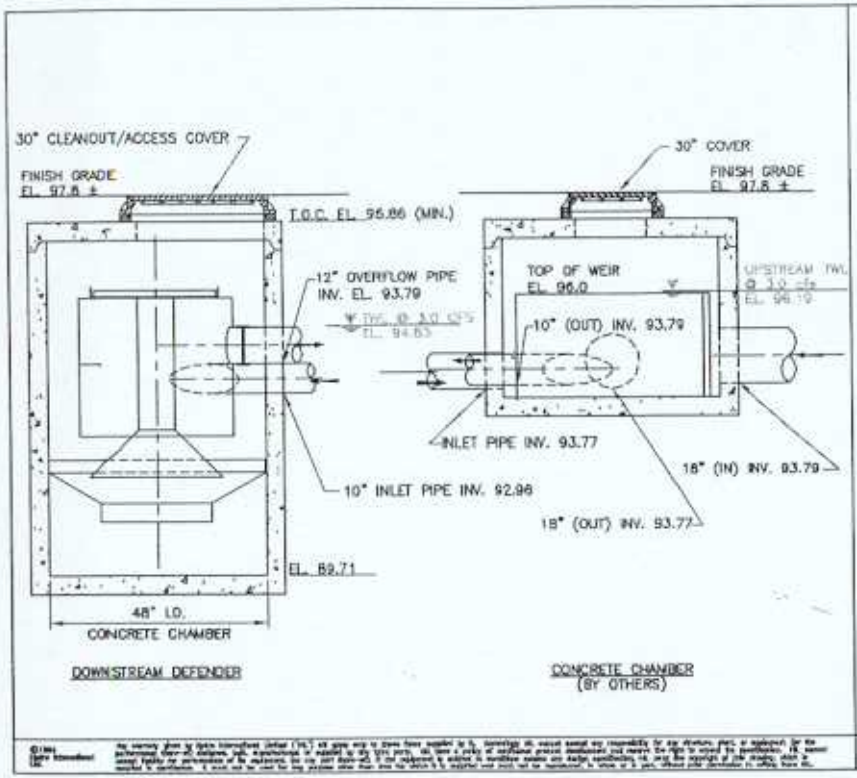
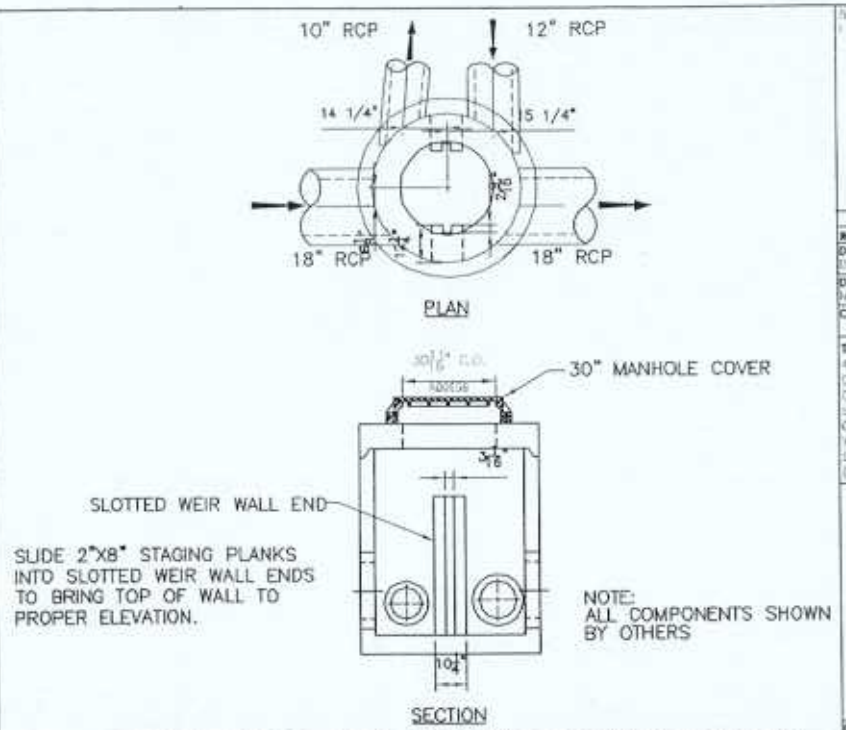
P.O. BOX 26
SYRACUSE, NY 13214
PHONE: (315) 449-3010, FAX: 449-0443

PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
LAYOUT DETAILS
EAST SENECA TRNPK. DOWNSTREAM DEFENDER
CORNER OF SENECA DR. AND E. SENECA TRNPK.
ONONDAGA COUNTY, NEW YORK

SHEET NO.
DD-2





Rev	By	Date	Description
Date		03/17/00	Scale: NTS
Drawn by: MPG			Checked Eng.
Checked Prod.			Approved by

Title
4'-Ø I.D. DIA. DOWNSTREAM DEFENDER™ WITH BYPASS
ONONDAGA LAKE WATERSHED PROJECT
LAYOUT OF PROP. DIVERSION MANHOLE

H.I.L. TECHNOLOGY INC.

CAD Ref: PROPMH
Wipe No. 2000/034
Drawing No. PROPMH Rev.

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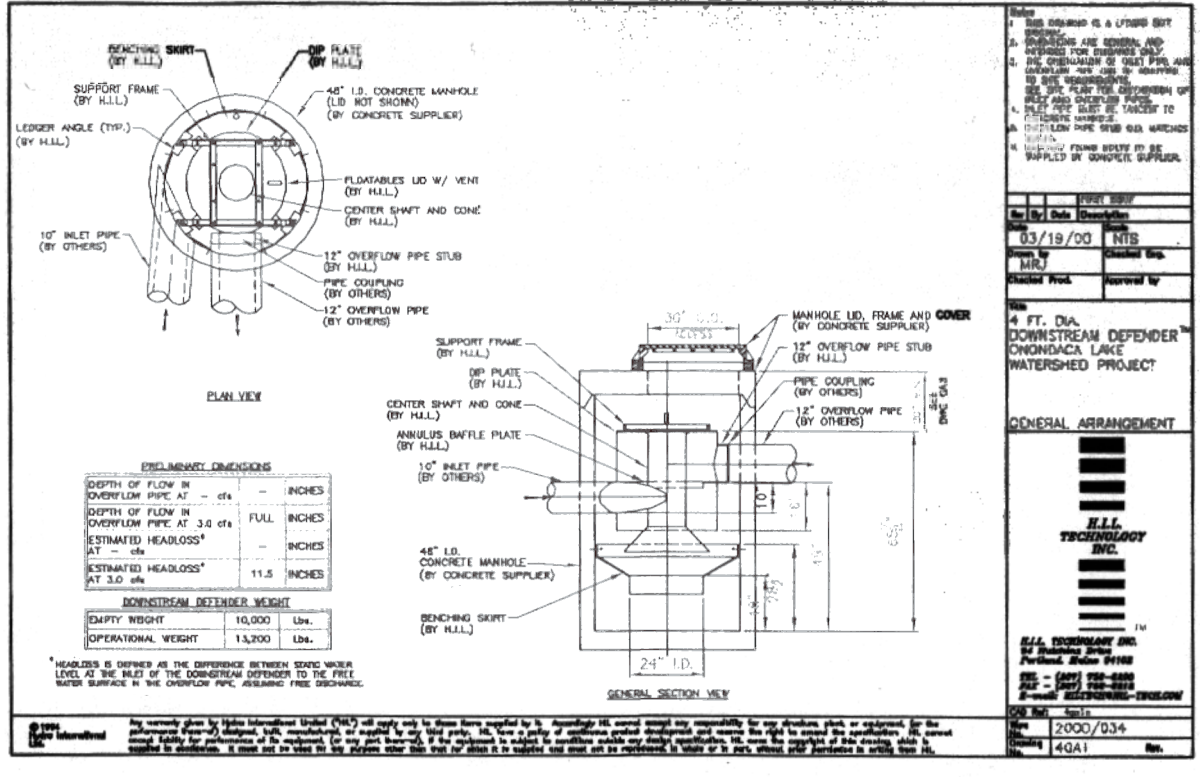
PROJECT NO.:	M00/04
DATE:	03/30/00
DRAWN BY:	MJL
CHECKED BY:	AR
SCALE:	AS SHOWN
FILENAME:	DWGSTRM DEFENDER(S).DWG

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5710 COMMONS PARK
P.O. BOX 26
SYRACUSE, NY 13214
PHONE: (315) 449-3010, FAX: 449-0443

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

MANHOLE DIVERSION DETAILS
EAST SENECA TRNPK. DOWNSTREAM DEFENDER
CORNER OF SENECA DR. AND E. SENECA TRNPK.
ONONDAGA COUNTY, NEW YORK

DD-3



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DATE:	03/30/00
DRAWN BY:	ML
CHECKED BY:	JJL
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FILENAME:	OWNERN DEFENDERLONG

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5710 COMMONS PARK
P.O. BOX 26
SYRACUSE, NY 13214
PHONE: (315) 449-3010, FAX: 449-0443

PROJECT TITLE
ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

SHEET TITLE
GENERAL ARRANGEMENT DETAILS
EAST SENECA TRNPK. DOWNSTREAM DEFENDER
CORNER OF SENECA DR. AND E. SENECA TRNPK.
ONONDAGA COUNTY, NEW YORK

SHEET NO.
DD – 4

Appendix F

Downstream Defender Approval Letter

From The City Of Syracuse

John P. Copanas
City Clerk

Joyce W. Parker
Deputy City Clerk

OFFICE OF THE CITY CLERK

Roy A. Bernardi, Mayor

July 18, 2000

Peter Moffa
Moffa & Associates
Consulting Engineers
PO Box 26
Syracuse, NY 13214

Dear Mr. Moffa:

Enclosed please find a certified copy of Ordinance No. 327 adopted by the Syracuse Common Council on July 10, 2000, and signed by the Mayor on July 12, 2000.

Ordinance No. 327 granting permission to Moffa and Associates to construct and install a specially manufactured srotmwater manhole and ancillary structures in the City's sewer system within the City right-of-way at 134 East Seneca Turnpike for the purpose of improving water quality in Onondaga Creek and Onondaga Lake.

Please pay particular attention to stipulation no. 8 stating that Moffa and Associates shall file with the City Clerk written acceptance of this ordinance and its terms, conditions and provisions, within (30) thirty days from the adoption of this ordinance. Such acceptance shall constitute an agreement by Moffa and Associates to abide by the terms and conditions of this ordinance.

Any permits necessary relative to the establishment can be obtained by presenting this copy of the Certified Ordinance to the proper officials at City Hall Commons.

As always, if you have any questions or require additional information, please do not hesitate to contact me at 448-8217.

Sincerely,

John P. Copanas KH

John P. Copanas,
City Clerk

/kh

enclosures
pasordno.327.let

Appendix G

Vegetated Filter Strip Approval Letter

From The Burnet Park Zoo Director

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5710 COMMONS PARK
P.O. BOX 26
SYRACUSE, NY 13214
(315) 449-3010
Fax: (315) 449-0443

June 22, 1999

Anne Baker
Zoo Director
Burnet Park Zoo
Onondaga County Parks
One Conservation Place
Syracuse, NY 13204

Re: Vegetative Strip for Nonpoint Source Pollution
from Burnet Park Zoo Parking Lots

Dear Mrs. Baker:

Thank you for taking the time to meet with us yesterday regarding the above referenced best management practice. We were pleased with your enthusiasm towards the project. The purpose of this letter is to present a brief background of the project and request your approval to implement and monitor a vegetative strip at the edge of Parking Lot 2. The vegetative strip will be designed to treat stormwater runoff from a portion of this parking lot.

The proposed work will be performed by Moffa and Associates Consulting Engineers and administered through the Central New York Regional Planning and Development Board as part of the Onondaga Lake Watershed Nonpoint Source Environmental Benefit Project (EBP). The Onondaga Lake Watershed Nonpoint Source EBP is part of the 1997 Consent Agreement that was signed by Onondaga County, NYS Department of Environmental Conservation (DEC) and Atlantic States Legal Foundation (ASLF). This agreement is intended to remedy continuing sources of pollution to Onondaga Lake and bring the lake into compliance with the Federal Clean Water Act by 2012. While the majority of the $370 million committed to this project will be used for improving the METRO wastewater treatment plant in Syracuse and for reducing combined sewer overflows, a small portion of the funds are targeted towards the Onondaga Lake Watershed Nonpoint Source EBP which includes the implementation of agricultural and urban best management practices.

The present plan calls for designing and implementing a vegetative strip as part of the urban best management practices during the summer of 1999. Please refer to the attached figure for a conceptual drawing of the intended vegetative strip. The vegetative strip will be designed to accept stormwater runoff from a portion of the southeast section of Parking Lot 2. Implementing the vegetative strip will likely entail removing the existing cobble stone stormwater conveyance system and replacing it with fill/top soil and native grasses. Some regrading of the existing conveyance system will be required. Efforts will be made to retain the existing trees. If this is not successful, then the trees will be replaced. The design will be limited to the area currently occupied by the existing conveyance system and will not intrude on parking spaces.

Once the vegetative strip is implemented, it will be allowed to establish itself for approximately ½ year before monitoring begins. Monitoring is scheduled to take place during the spring, summer and fall of 2000. Six rain/stormwater runoff events will be monitored during this time. A final report on the effectiveness of the best management practices, results of the monitoring, and your thoughts regarding the operation and maintenance issues of the best management practices, would be completed in the summer of 2001. The most obvious maintenance issue is that of cutting the grass. It would be most convenient if Onondaga County would take responsibility for this activity during their routine grass cutting duties at the zoo.

Prior to beginning any physical site work, we will confirm the nature of the work, time and location with you and your office. It would be helpful if you could provide the stormwater plans for the existing parking lot prior to design.

We look forward to working with you and having the opportunity to make improvements at the Burnet Park Zoo with the intent to improve water quality. If this is acceptable and you are willing to participate in this project, please co-sign this letter and return one copy.

Very truly yours,

MOFFA & ASSOCIATES

Peter E. Moffa, P. E.
Principal

John J. LaGorga
Project Manager

Burnet Park Zoo
Onondaga County Parks

Anne Backer
Zoo Director

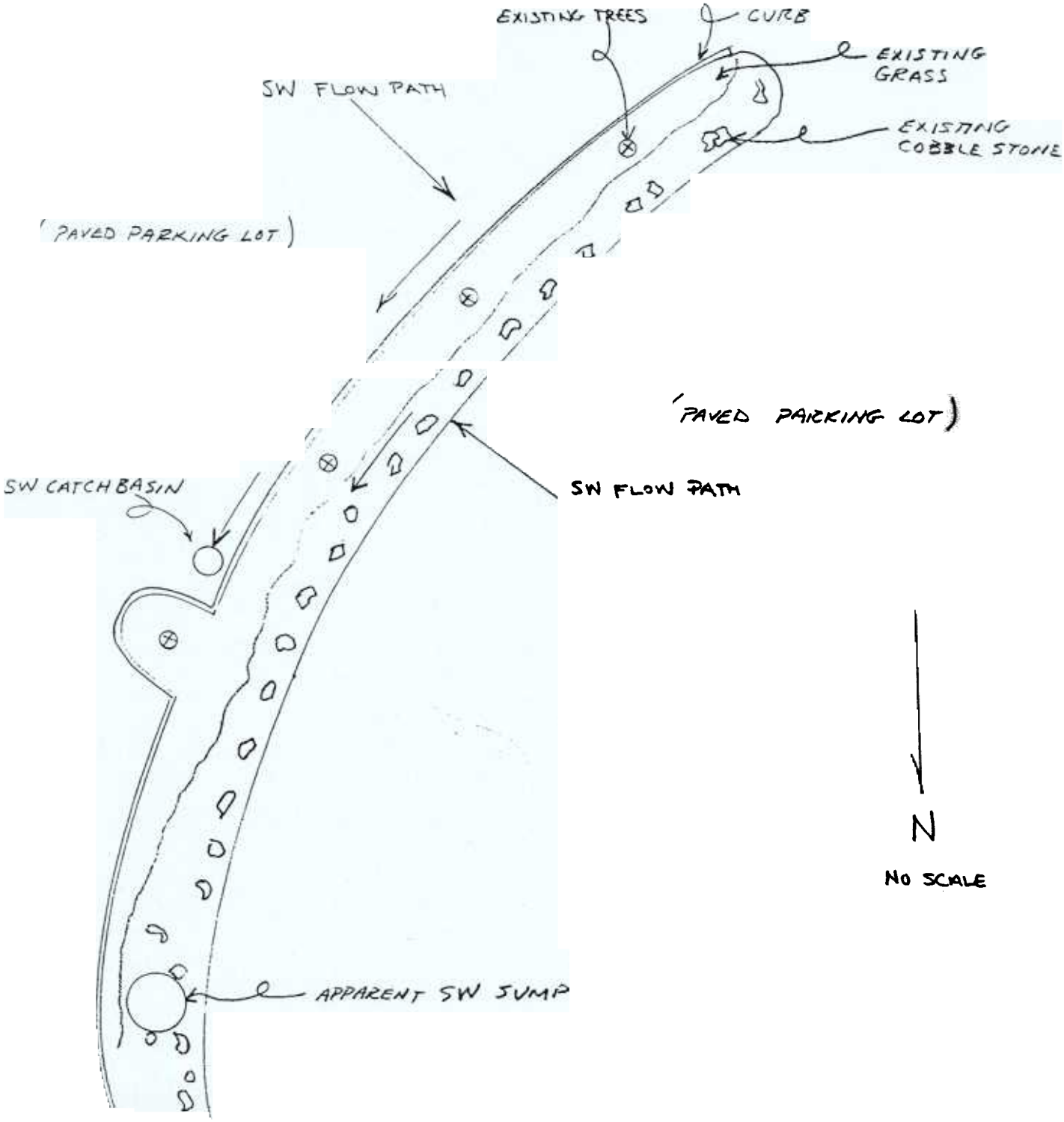
Attachment

cc: Benjamin Manton
Brian Jerose

MOFFA & ASSOCIATES
CONSULTING ENGINEERS

PROJECT	PROJ. NO.	BY	DATE	SHEET
EXISTING SW CONVEYANCE PARKING LOT 2	151.01	JJL	6/21/99	1/2

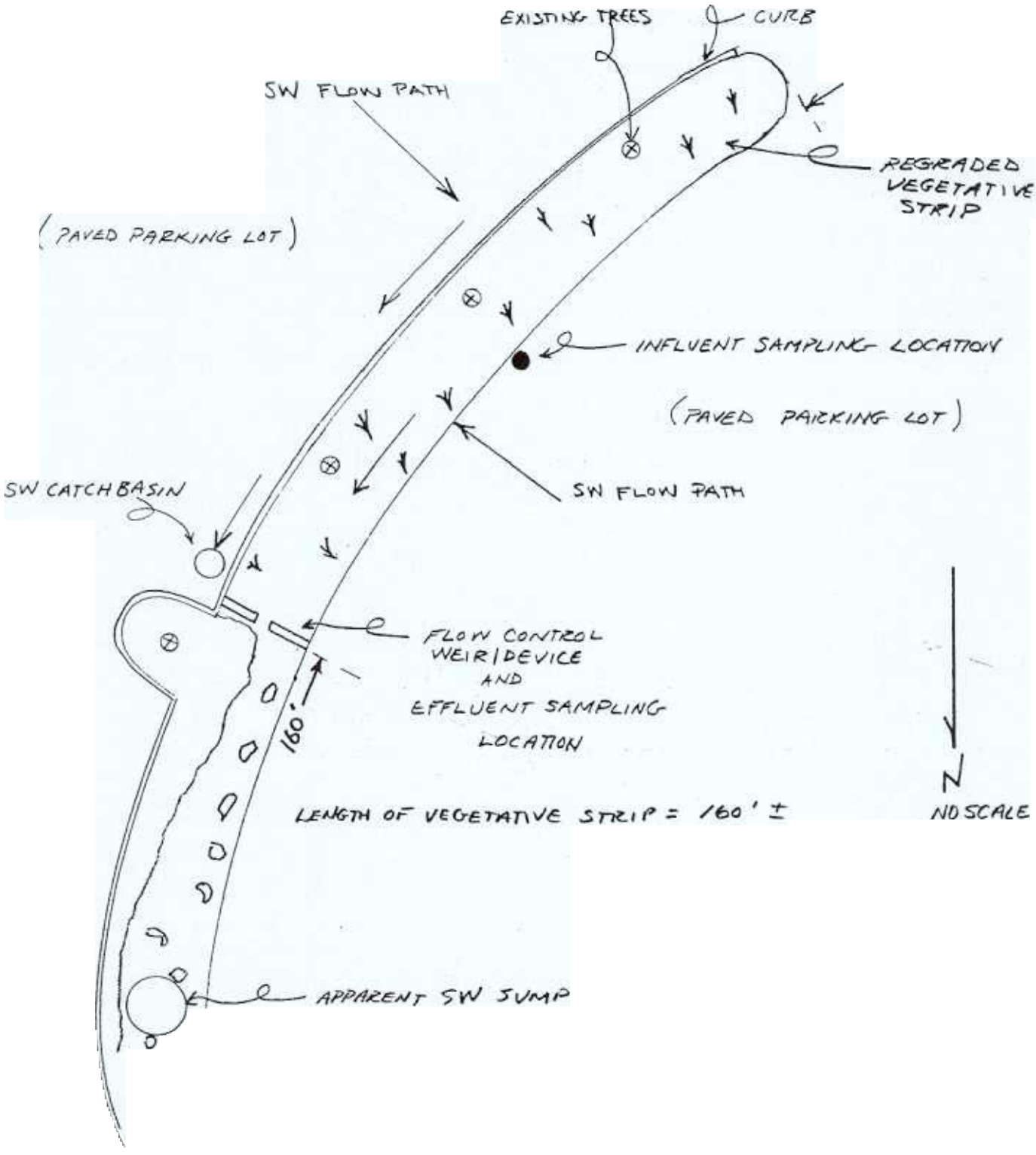
BURNET PARK ZOO



MOFFA & ASSOCIATES
CONSULTING ENGINEERS

ECT	PROJ. NO.	BY	DATE	SHEET
VEGETATIVE STRIP FOR PARKING LOT 2	151.01	JJL	6/21/99	2/2

BURNET PARK ZOO



LENGTH OF VEGETATIVE STRIP = 160' ±

Appendix H

Zoo Design Drawings

CONTRACT DRAWINGS

ONONDAGA LAKE WATERSHED
NONPOINT SOURCE
ENVIRONMENTAL BENEFIT PROJECT

VEGETATIVE FILTER STRIP AT BURNET PARK ZOO
ONONDAGA COUNTY, NEW YORK

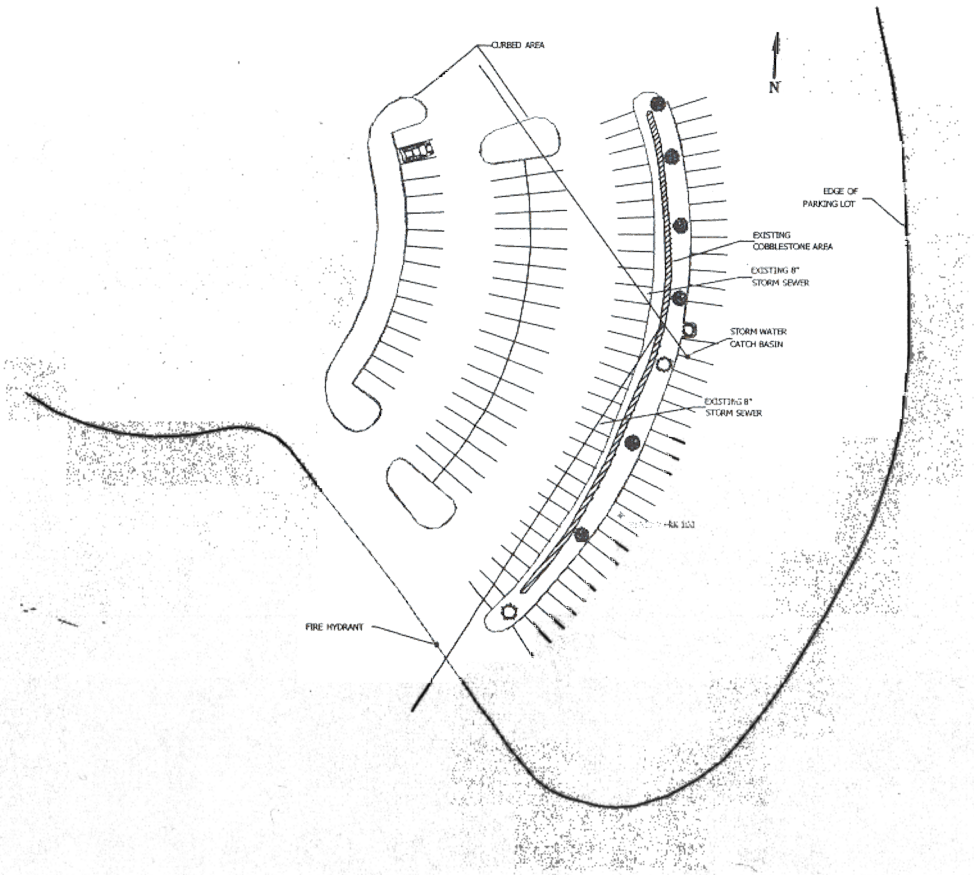
CENTRAL NEW YORK
REGIONAL PLANNING AND DEVELOPMENT BOARD

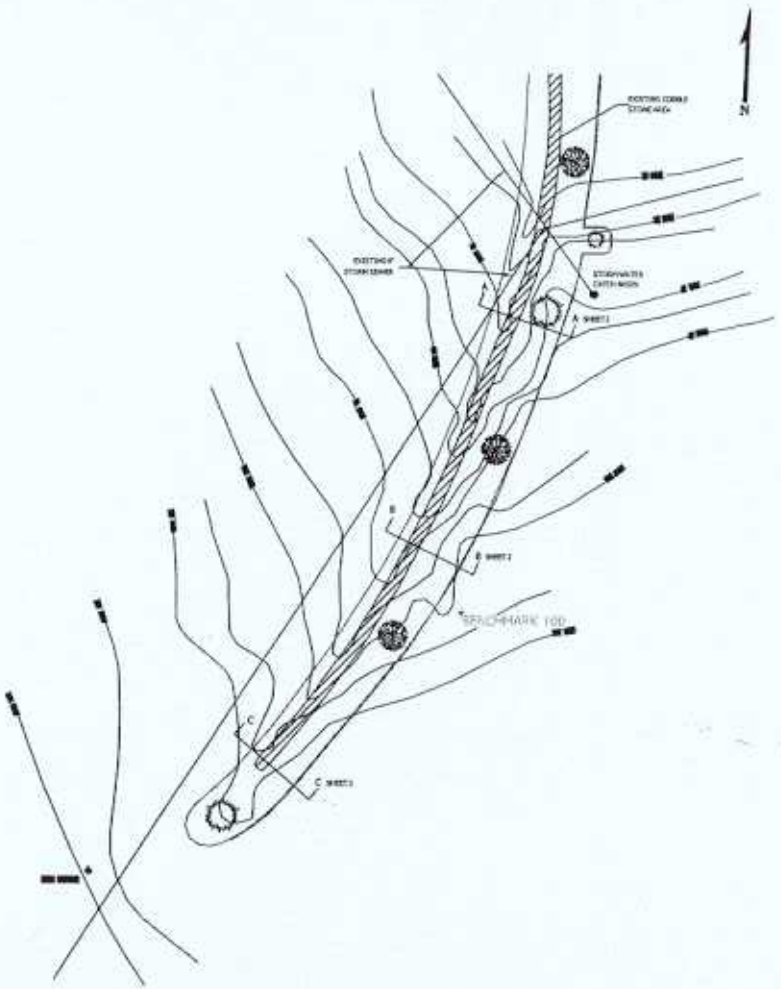
LOCATION PLAN
BURNET PARK ZOO
1 CONSERVATION PLACE
SYRACUSE, NY 13204

INDEX OF DRAWINGS

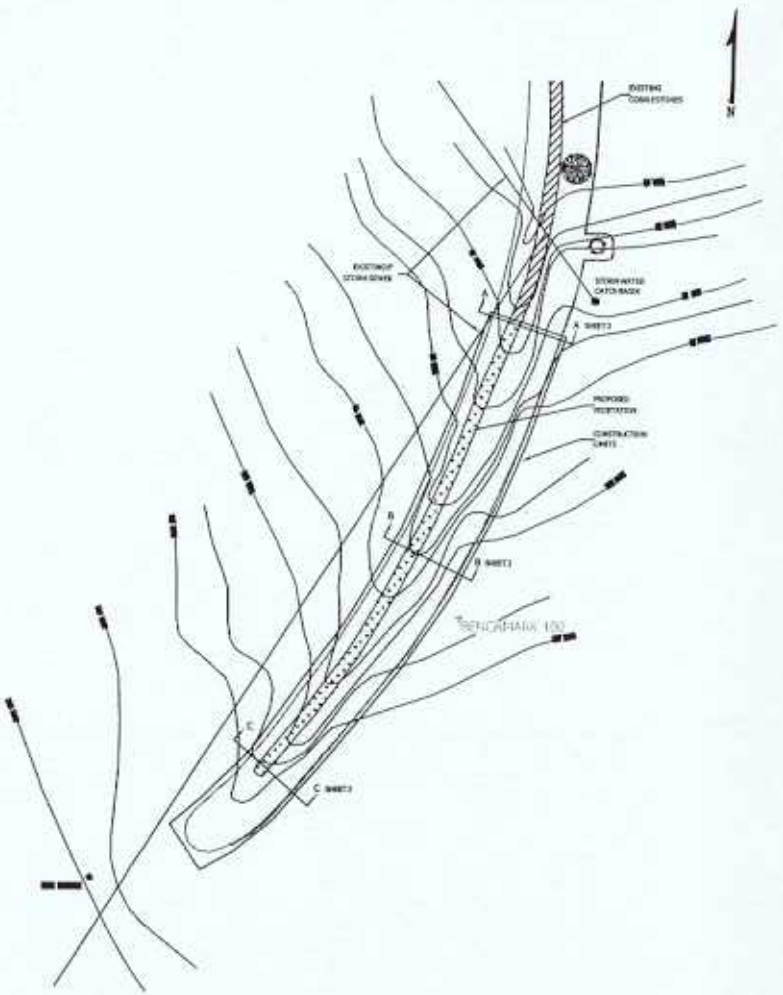
SHEET 1: EXISTING AND PROPOSED SITE PLANS
SHEET 2: EXISTING AND PROPOSED SECTIONS
SHEET 3: MISCELLANEOUS LOCATION PLANS

MOFFA & ASSOCIATES
CONSULTING ENGINEERS
5710 COMMONS PARK
P.O. BOX 26
SYRACUSE, NY 13214
PHONE: (315) 446-3010
FAX: (315) 446-0443



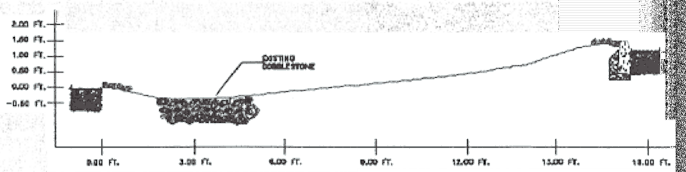


PLAN OF EXISTING COBBLESTONE AREA
SCALE: 1" = 30'



PLAN OF PROPOSED COBBLESTONE AREA
SCALE: 1" = 30'

EXISTING AND PROPOSED SITE PLANS	DRAWN BY: CHECKED BY: CHECKED BY:	MOFFA & ASSOCIATES CONSULTING ENGINEERS	ONONDAGA LAKE WATERSHED NONPOINT SOURCE ENVIRONMENTAL BENEFIT PROJECT	VEGATATIVE FILTER STRIP BURNET PARK ZOO ONONDAGA COUNTY, NEW YORK	PROJECT & TASK NUMBER SHEET NO. 1



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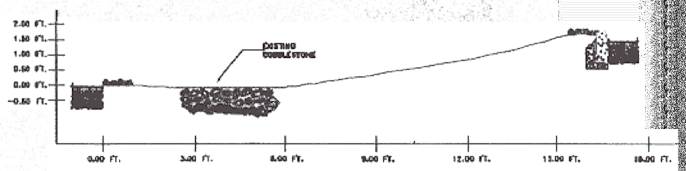

SECTION B–B
EXISTING GRADE
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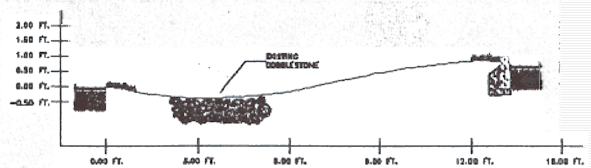

SECTION C–C
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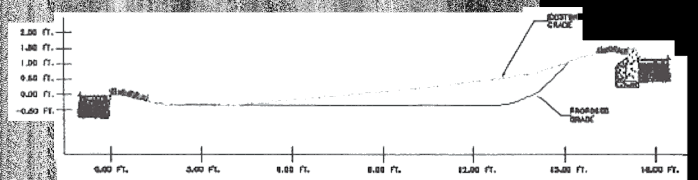

SECTION A–A
PROPOSED GRADE
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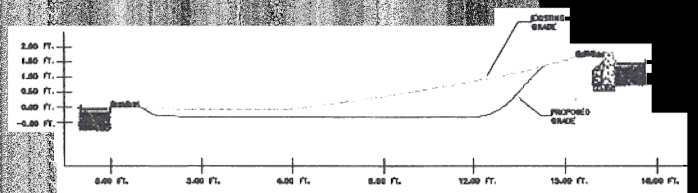

SECTION B–B
PROPOSED GRADE
SCALE 1" = 4'

EXISTING AND PROPOSED SECTIONS

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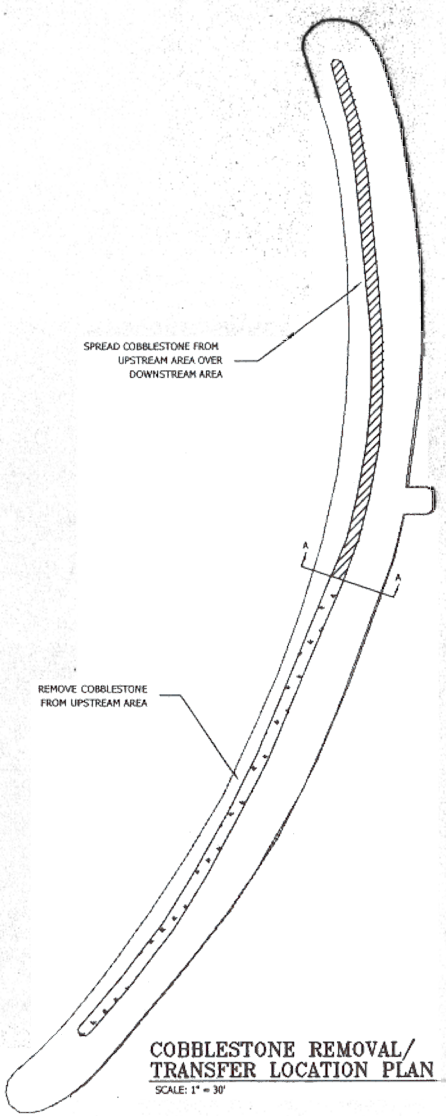
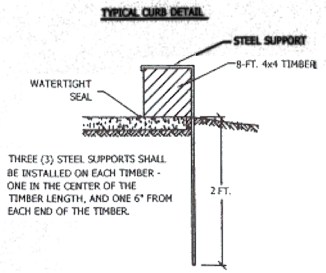
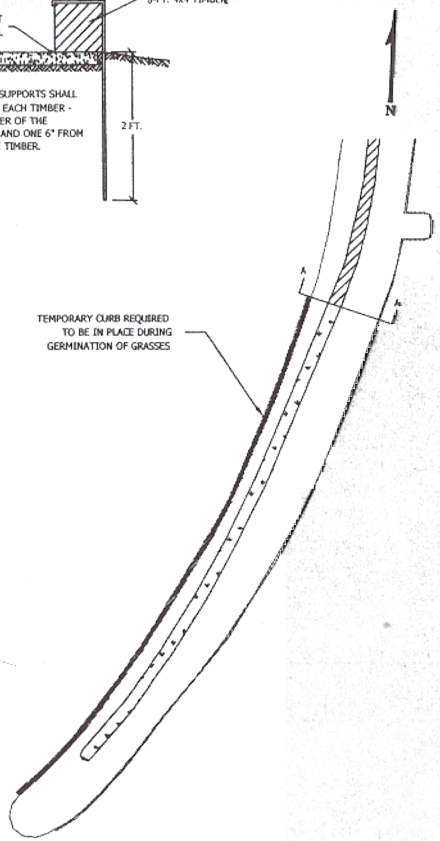
CHECKED BY:
CHECKED BY:



COBBLESTONE REMOVAL/ TRANSFER LOCATION PLAN

SCALE: 1" = 30'





FIRST TEMPORARY CURB LOCATION PLAN

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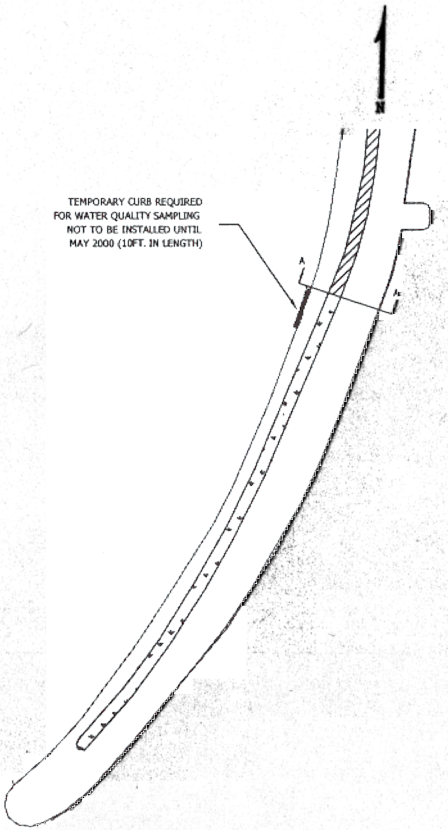

SECOND TEMPORARY CURB LOCATION PLAN

SCALE: 1" = 30'

SHEET TITLE: MISCELLANEOUS LOCATION PLANS	DRAWN BY: CHECKED BY: CHECKED BY:	MOFFA & ASSOCIATES CONSULTING ENGINEERS	ONONDAGA LAKE WATERSHED NONPOINT SOURCE ENVIRONMENTAL BENEFIT PROJECT	VEGATATIVE FILTER STRIP BURNET PARK ZOO ONONDAGA COUNTY, NEW YORK	PROJECT & FILE NUMBER SHEET NO. 3